Medicalised childbirth: Variation in care and drivers of maternal health service provision in Queensland, Australia.

Thesis submitted by

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Statement of the contribution of others

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This Ph.D. thesis contains several published papers, and all persons who contributed to these articles have been included as co-authors. The co-authors for the papers in this thesis are the members of the supervisory team including Associate Professor Emily Callander, Associate Professor Stephanie Topp and Dr Daniel Lindsay. For each of the publications contained within this thesis, I conceived, designed, and planned the study, and undertook the data analysis. All authors contributed to the interpretation of the data, drafting the manuscript, and approved of the final document. Editorial assistance for this thesis was provided by my supervisors.

Statement of Sources

I declare that this thesis is my work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given. Every reasonable effort has been made to acknowledge the owners of copyright material. I would be pleased to hear from any copyright owner who has been omitted or incorrectly acknowledged.

Haylee Fox Date: 5/06/2021

Abstract

Background:

The way in which women give birth in western cultures has changed dramatically over the past century. Women have shifted from predominantly giving birth at home, to giving birth in hospitals. This transformation has increased the use of medical and surgical interventions for women during labour and birth, with the justification to reduce the risk of maternal and neonatal mortality and to improve the health outcomes of women and babies.

Globally, there has been a steep increase in the use of medical and surgical interventions during labour and birth in many parts of the world. The rate of caesarean section has almost doubled between 2000 and 2015 and is one of the most commonly performed surgeries in many countries. Similar to the global trend, Australia has also experienced an increase in the use of all obstetric interventions. At the same time, both globally and nationally, there is evidence of inequitable maternal healthcare provision, health service coverage, and maternal health outcomes between population groups.

The overarching aim of this thesis is to gain an in-depth understanding of the patterns of maternal health service use among the Australian population, and drivers of maternal healthcare trends from various levels of the health system. To address this aim, this thesis will answer the following questions:

1. Does variation in maternity care exist between subpopulation groups and hospital and health service jurisdictions in Queensland, Australia?
2. What are the clinical drivers and health providers' reasons for providing caesarean sections in Queensland public and private hospitals?
3. In what ways have macro-level health and economic policies influenced the management of maternal health care in Australia?

Methods:

This thesis used a whole-of-population linked administrative healthcare and cost dataset, which contains all women who gave birth in Queensland between 1 July 2012 and 30 June 2015 (n=186,789), plus their resultant babies (n= 189,909), including follow-up health service data until 30 June 2016. All individuals were identified from the Queensland Perinatal Data Collection and Queensland Birth Registry by Queensland Health's Statistical Services Branch. The records were then linked to Queensland Hospital Admitted Patient Data Collection, Registrar General Deaths,

Emergency Department Information System, and Hospital and Health Service Funding and Costing Unit records. The records were then linked by the Australian Institute of Health and Welfare to the Medicare Benefits Schedule and Pharmaceutical Benefits Scheme claims records for the relevant period.

Results and Discussion:

Research question 1: Variation in maternity care provision between population groups and hospital and health service jurisdictions.

Although a higher percentage of First Nations women had maternal health risk factors compared to non-First Nations women, First Nations women were 0.4 (CI: 0.3-0.41) times less likely to attend 8 or more antenatal care appointments and 0.7 (CI: 0.65-0.71) times less likely to commence antenatal care in the first trimester compared to non-First Nations women. Women in the 3 lowest socioeconomic quartiles were all significantly less likely to attend more than 8 antenatal care appointments and significantly less likely to commence antenatal care in the first trimester compared to women in the highest socioeconomic quartile. First Nations women, rural and remote women, and women in the lowest socioeconomic quartiles were less likely to receive mental health support compared to non-First Nations, urban, and higher socioeconomic women, respectively. On average, First Nations women (4.5), rural and remote women (4.7), and women in the most disadvantaged quartile (6) accessed fewer primary care services during the perinatal period compared to their non-First Nations (6.8), socioeconomically advantaged (8.2) and urban (6.8) and regional counterparts (8.7).

After adjusting for key clinical characteristics that might increase the likelihood of receiving an obstetric intervention, First Nations women were 0.94 (CI: 0.90-0.99) times less likely to have a caesarean section than non-First Nations women. Similarly, women in the lowest socioeconomic quintile were 0.93 (CI: 0.89-0.93) less likely to have a caesarean section than women in the most wealthy quintile. Women living in inner regional areas were 0.96 (CI:0.93-0.99) times less likely to have a caesarean section than women living in major cities. First Nations women (0.70, CI: 0.65-0.77), remote (0.77, CI: 0.72-0.83) and very remote (0.85, CI: 0.77-0.94) women and women in the lowest socioeconomic quintile (0.80, CI: 0.75-0.86) were less likely to have an instrumental vaginal birth compared to their non-First Nations, urban and higher socioeconomic counterparts. First Nations women were 0.86 (0.82-0.89) times less likely to have an induction of labour compared to non-First Nations women. Women in the lowest socioeconomic quintile were 0.79 (CI: 0.73-0.86) times less likely to have an induction of labour compared to women in the highest socioeconomic quintile. First Nations women (1.14 CI: 1.09-1.19), inner regional (1.06 CI:1.03-1.09), outer regional

(1.01 CI:0.9-1.0.4), very remote (1.05 CI:0.99 -1.11) and women in the lowest (1.15 CI:1.10-1.20), second-lowest (1.11 CI:1.08 -1.14) middle (1.04 CI:1.01-1.08) and upper-middle wealth quintile (1.15 CI:1.12 -1.19) were all significantly more likely to have an unassisted vaginal birth than their relevant counterparts.

Caesarean sections were highest at Private hospitals (45.8%) and in South West (36.2%), Townsville (31.6%), Metro South (30.9%), and Cairns (30.7%) Hospital and Health Service jurisdictions. The Gold Coast Hospital and Health Services (23.6%) and Torres and Cape (22.3%) had the lowest percentage of caesarean sections. The variation in caesarean sections between the Hospital and Health Services with the highest and the lowest percentage was 24 percentage-points, for induction of labour it was 13 percentage points, for instrumental vaginal births it was 7 percentage points, for episiotomy it was 7 percentage points, for epidural it was 11 percentage points and for non-instrumental vaginal deliveries it was over 30 percentage points difference.

The variation observed in obstetric practice may somewhat be attributable to differences in Clinical Practice Guidelines (CPGs) and the interpretation of evidence between hospitals and health providers and differences in hospital or health provider culture and practices rather than the individual needs of birthing women. Despite a National maternal health care reform agenda aimed at improving woman-centredness, there has been a lack of targeted measurement and evaluation of whether this has been achieved. Independently commissioned implementation research is lacking to understand whether, what, and how the intended reform agenda of achieving woman-centred care is needed. Such evidence could accompany new guidelines for maternal health care reform in Australia. Further research is also needed to obtain up-to-date information on Australian women's birth preferences.

<u>Research question 2: Clinical drivers and health provider reasons for providing caesarean sections in Queensland public and private hospitals</u>

The top 2 clinician-reported reasons for providing a caesarean section in public hospitals were 'labour and delivery complicated by an abnormal fetal heart rate' (23%) and 'inadequate contractions' (22.8%). Abnormal fetal heart rate was most probable among those who had their membranes artificially ruptured; received oxytocin; did not have an obstructed labour, and had an epidural. Inadequate contractions were most probable among women who had an epidural; received oxytocin; had their membranes artificially ruptured, and experienced fetal stress.

When providing interventions such as epidural, artificial rupture of membranes, and oxytocin, clinicians need to take into consideration and adequately inform women of the implications such as

the need for a caesarean section, potentially initiating a cycle of caesarean sections in future births. Maternal health care providers need to provide education to women during the antenatal period about preventative measures that minimize the need for medical and surgical intervention during labour and birth. Future research should consider the health provider and health service-level factors that surround the provision of obstetric interventions.

In private hospitals, elective caesarean section (18.4%) was the top clinician-reported reason for providing a primary caesarean section. Other major drivers of primary caesarean sections in the private sector were abnormal fetal presentation and Assisted Reproductive Technology. Women giving birth in the private sector should be given evidence-based information during the antenatal period, which should particularly be targeted at women who conceive via Assisted Reproductive Technology and women whose baby is in the breech position, to make an informed decision regarding the mode of birth and management options. If health providers are not experienced and confident with vaginal breech deliveries, referrals could be made so that if a woman does want to have a vaginal breech birth and there is a service available, she can do so. Future research should consider the interaction between health providers and women to better understand why women without clinical indication are receiving caesarean sections and also a greater understanding of private providers' birth preferences.

Research question 3: Macro-level health and economic policies and their influence on the management of maternal health care in Australia.

In reviewing the healthcare financing literature, four important trends that influence the provision of maternal health care and health service provision were identified. The first is a long-term trend towards the privatization of maternity care, whereby the introduction of private health incentives was associated with a rise in private birth rates resulting in almost 30% of women giving birth in the private sector. The second trend is there has been increasing use of medical technologies within prenatal and intrapartum care. Obstetric involvement and the use of medical interventions during pregnancy and childbirth have become routine even in low-risk pregnancies. The third trend is the current funding models in Australia incentivize volume of care as opposed to quality care. Funding models such as Activity Based Funding (ABF), which is dominant in the public sector, and the fee-for-service model, which is dominant in the private sector, can create an incentive for delivering ‘volume’ of maternal care, rather than quality of care. While this incentive exists in both the public and private sector, in the private sector the fees are unregulated, and providers operate on a for-profit basis. The fourth trend was a limiting of access to gold standard midwifery continuity of care models as the current health system financing mechanisms in Australia actively restrict access to this

option. Also, existing Medicare Benefits Schedule items for obstetric services are medically focused and items are almost exclusively limited to services provided by obstetricians, GP obstetricians, and GPs.

To ensure that birth outcomes are meeting the needs of all women**,** consideration needs to be given to implementing quality-based indicators that preference woman-centered outcomes during pregnancy and childbirth over funding models that reward volume of care, alongside prioritisation of increasing access to publicly funded midwifery continuity of carer models to ensure the current levels of consumer demand are being met.

Conclusion:

This thesis presents a unique body of work on the patterns of maternal health service use among the Queensland population, and drivers of maternal healthcare trends from various levels of the health system. The strength of this study is the use of administrative healthcare data from an entire population, which minimises the risk of selection bias and not limiting the sample size of women from minority population groups that are often underrepresented in healthcare research. The findings in this thesis show that variation in maternal health care provision and health service coverage exists between groups of women, which is not solely attributable to the clinical need of women. The higher use of costly obstetric interventions for urban, higher socioeconomic and non-First Nations women, and the lower maternal health service coverage for rural and remote, First Nations and lower socioeconomic women provides evidence that healthcare resources for women in Queensland are inequitably distributed and that macro-level health and economic policies are in-part contributing to this trend.

List of publications

This thesis contains 6 chapters that have been published or are currently under review in peer review journals. Below is a list of publications contained within this thesis, and other publications and conference abstracts accepted during the candidature.

Thesis publications:

- **Fox H,** Callander E, Lindsay D, Topp S. Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers. *BMC Pregnancy and Childbirth*. 2019;19(1):226. DOI: https://doi.org/10.1186/s12884-019-2369-5

- **Fox H,** Topp SM, Callander E, Lindsay D. A review of the impact of financing mechanisms on maternal health care in Australia. *BMC Public Health*. 2019;19(1):1540. DOI: https://doi.org/10.1186/s12889-019-7850-6

- **Fox, H**., Callander, E., Lindsay, D., Topp, S. Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals. *Australian Health Review.* 2021. DOI: https://doi.org/10.1071/AH20014.

- **Fox, H**., Topp, S., Lindsay, D., Callander, E. A cascade of interventions: A classification tree analysis of the determinants of primary caesarean sections in Australian public hospitals**.** *Birth*. 2021. DOI: htpps://doi.org/ 10.1111/birt.12530

- **Fox, H**., Topp, S., Lindsay, D., Callander, E. Determinants of caesarean sections in Australian private hospitals. *Midwifery*. Under review. 2021

- **Fox, H**., Topp, S., Lindsay, D., Callander, E. Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia. *International Journal of Health Planning and Management*. 2021DOI: https://doi.org/10.1002/hpm.3277

- **Fox, H**., Topp, S., Lindsay, D., Callander, E. Response to: 'The "Cascade of interventions". Does it really exist?'

Other publications during Ph.D. candidature:

- Callander E, **Fox H**. Changes in out-of-pocket charges associated with obstetric care provided under Medicare in Australia. *Australian and New Zealand Journal of Obstetrics and Gynaecology*. 2018;58(3):362-5. DOI: https://doi.org/10.1111/ajo.12760

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- Toohill J, Callander E, **Fox H**, et al. Socioeconomic differences in access to care in Australia for women fearful of birth. *Australian Health Review*. 2019;43(6):639-43. DOI: https://doi.org/10.1071/AH17271

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- Callander EJ, Thomas J, **Fox H**, Ellwood D, Flenady V. What are the costs of stillbirth? Capturing the direct health care and macroeconomic costs in Australia. *Birth*. 2020;47(2):183-90. DOI: https://doi.org/10.1111/birt.12469

- Callander EJ, Topp S, **Fox H**, Corscadden L. Out-of-pocket expenditure on health care by Australian mothers: Lessons for maternal universal health coverage from a long-established system. *Birth*. 2020;47(1):49-56. DOI: https://doi.org/10.1111/birt.12457

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- Carlisle, K., Felton-Busch, C., Cadet-James, Y., Taylor, J., Bailie, R., Farmer, J., Passey, M., Matthews, V., Callander, E., Evans, R., Kelly, J., Preston, R., Redman-MacLaren, M., **Fox, H**., Esterman, A, Zwarenstein, M., Larkins, S. WOmen's Action for Mums and Bubs (WOMB) Trial Protocol: A Non-randomized Stepped Wedge Implementation Trial of Participatory Women's Groups to Improve the Health of Aboriginal and Torres Strait Islander Mothers and Children in Australia. *Frontiers in Public Health*. 2020;8:73. DOI: https://doi.org/10.3389/fpubh.2020.00073

- **Fox H,** Callander EJ. The cost of Hypertensive Disorders of Pregnancy to the Australian healthcare system. *Pregnancy Hypertension.* 2020;21:197-9. DOI: https://doi.org/10.1016/j.preghy.2020.06.007

- **Fox, H** & Callander, E. The cost of preterm birth to Australian mothers: assessing the financial impact of a birth outcome with an increasing prevalence. *Journal of Paediatrics and Child Health*. 2020.DOI: https://doi.org/10.1111/jpc.15278

- **Fox, H** & Callander, E. Health service use and health system costs associated with diabetes during pregnancy in Australia. Nutrition, Metabolism & Cardiovascular Diseases. 2021. DOI: https://doi.org/10.1016/j.numecd.2021.02.009

Conference abstracts during candidature:

- **Fox H**., Callander, E. 2017. The impact of having a premature baby on Australian mother's return to work and income following childbirth. *Australasian Tropical Health Conference*, Cairns, Australia.

- **Fox H**., Callander, E. 2018. The potential for big data to improve health systems research: using the Maternity1000 model to examine the socioeconomic characteristics of mothers receiving obstetric intervention during labour and birth in Australia. *Global Symposium on Health Systems Research*. Liverpool, UK.

- **Fox H**., Callander, E., Lindsay D., Topp S. 2019. Population trends and potential policy drivers of the medicalisation of childbirth in Australia. *Emerging Health Policy Research Conference*. University of Sydney, Sydney.

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Chapter four: Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia.

Fox H, Topp S, Lindsay D, Callander E. Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia. *International Journal of Health Planning and management*. 2021; DOI: https://doi.org/10.1002/hpm.3277

Chapter five: Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals.

Fox H, Callander E, Lindsay D, Topp S. Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals. *Australian Health Review*.2021; DOI: https://doi.org/10.1071/AH20014

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Section 3: A case study of the determinants of caesarean section provision in Queensland hospitals.

Chapter six: A cascade of interventions: determinants of caesarean sections in Australian public hospitals.

Fox H, Topp S, Lindsay D, Callander E. A cascade of interventions: determinants of caesarean sections in Australian public hospitals. *Birth.* 2021. DOI: https://doi.org/10.1111/birt.12530

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Fox H, Topp S, Lindsay D, Callander E. Determinants of caesarean sections in Australian private hospitals. *Midwifery*. Under review. 2021.

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Fox H, Topp SM, Callander E, Lindsay D. A review of the impact of financing mechanisms on maternal health care in Australia. BMC public health. 2019;19(1):1540. DOI: https://doi.org/10.1186/s12889-019-7850-6

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Chapter 1: Introduction

Childbirth can be a hugely meaningful and transformational event on a physical, psychological, and spiritual level for many women (1). A woman's perception of her childbirth experience is shaped by the physical birth itself and can have a profound effect on her happiness and functioning, adjustment to parenthood, her feelings towards her newborn child, subsequent development of the child (2-4), and the subsequent health and wellbeing of both the woman and child (5). Considering the far-reaching impacts of childbirth, the health care that is received during the intrapartum period is an important determinant of health and wellbeing for both women and children.

A brief history of maternal health care in Australia

Over the past 100 years, there have been dramatic changes to intrapartum care in western cultures. In Australia, which is the country of focus in this thesis, there have been significant changes in how maternity care is provided. Before the eighteenth century, European Australian women were traditionally attended to in their home by other women such as friends or relatives with experience with childbirth, or a midwife would attend as a guest. A significant transformation took place in the post-war period whereby women moved from giving birth at home to giving birth in a hospital (6). This trend gained momentum throughout the twentieth century and today most (97%) women in Australia give birth at a health facility in which the birth is medically managed by either a doctor or midwife or both (7).

In pre-colonial Australia, Aboriginal and Torres Strait Islander (hereafter, respectfully referred to as First Nations) women received support from a local elder woman (also referred to as a Traditional Birth Attendant) that followed Grandmother's Law, whereby the birth would take place 'on Country'[1] with support from many other women (8). At present, many First Nations women lack choice and control over their birthing options, with First Nations women who live in remote areas and discrete Aboriginal and/or Torres Strait Islander communities being forced to relocate off Country to give birth at a regional hospital often in isolation from family and support networks. Such obstetric practices are almost diametrically opposed to the traditional birthing practices of First Nations women (8).

Little data exists on the health outcomes of First Nations women and babies prior to colonization, however, maternal and fetal mortality is documented as being low (9). From a population

[1]'On Country' is a term used by the First Nations peoples of Australia, which refers to their ancestors' land.

perspective, over the past five decades, there has been a general decline in maternal and neonatal mortality in Australia (10). However, there is a large body of evidence that suggests that the current biomedical approach to maternal health care provision can also produce harm to women and babies (11), in addition to the associated cost of utilising healthcare resources (12).

The current state of maternal health care in Australia

Maternity care in Australia includes antenatal, intrapartum, and postnatal care for women and babies up to six weeks after birth. Care is provided through a mix of public and private settings, with planning and delivery primarily undertaken by the states and territories through publicly funded programs, with the Commonwealth providing national direction. All women are eligible for public maternity care, which is provided in public hospitals. However, there is also a choice to receive private maternity care. Approximately 97% of women in Australia give birth in either a public or private hospital, with the remainder giving birth at home (13).

Maternity care is provided by a range of healthcare professionals via a range of different models of care. The main options for models of maternity care in Queensland include midwifery-led continuity of care, which is provided by a midwife or group of midwives within a public hospital; Private midwife care, which is provided by a midwife or group of midwives from a private group practice. In the private midwife model of care, there is the option to give birth in a hospital or at home (if available in the local area); General Practitioner (GP) shared care, which is shared between the woman's GP and the local hospital doctors and midwives; private obstetric care, which is provided by an obstetrician in either a private or public hospital; and public hospital maternity care, which is provided at the hospital by hospital-employed midwives and/or doctors (14).

Inequities in maternity care: a global perspective

Each year, approximately 140 million babies are born around the world (15), with maternal outcomes varying widely across countries and regions, within countries and between demographic and socioeconomic populations (16). Improvements in healthcare, nutrition and hygiene mean that maternal deaths are a lot less common today compared to 25 years ago. Globally, maternal mortality has fallen by almost half (44%) over the last 25 years (15). However, maternal death disproportionately affects poorer women (17-20). In low-income countries, a woman's risk of dying during pregnancy and childbirth is 46 times higher (546 per 100,000 births) than in high-income countries (12 per 100,000 births). Of the maternal deaths that occur annually, 99% are in low to middle-income countries. Within countries, women with the least education are nearly six times as likely to die compared with those with the highest education (21).

An unequal uptake of maternity care services such as access to a skilled birth attendant also exists between regions and countries, within countries, and between demographic groups and wealth quintiles (22-24). Disparities in access to care and the uptake of interventions can contribute to the wide variation in maternal morbidity and mortality with access to both primary and secondary care affecting health outcomes (25). For women who access maternity services, some receive exceptional care, but many women experience one of two extremes: 'too little, too late' or 'too much, too soon' (26). Too little, too late is when women lack access to quality, timely maternity care, which is typically experienced in low-income countries and among economically disadvantaged populations in middle and high-income countries. Too much, too soon, which is at the other extreme, is when antenatal, intrapartum, and postnatal care encourages or forces women into unnecessary medical procedures, which may cause harm, raise health costs, and contribute to a culture of disrespect and abuse (27).

Globally, there has been a steep increase in the use of medical and surgical interventions during labour and birth in many parts of the world. The rate of caesarean section has almost doubled between 2000 and 2015 from 16 million (12.1%) to 29.7 million (21.1%) and is one of the most commonly performed surgeries in many countries (28). Alongside caesarean sections, the use of other obstetric interventions is also rising. Obstetric interventions are defined by the author as medical or surgical measures taken by a health practitioner whereby the process of labour and/or birth is intervened. The obstetric interventions that will be examined in this thesis are caesarean section; induction of labour (augmentation and oxytocin); instrumental vaginal birth (forceps and vacuum), episiotomy, and epidural analgesia.

The World Health Organization (WHO) estimates that approximately 6.2 million excess caesarean sections are performed annually (29). Excess caesarean sections are defined as 'those that are performed in the absence of medical indications'(30). It may not seem applicable to determine a specific rate for caesarean sections as different populations have different levels of need. However, in many countries, a caesarean section rate higher than 10% of the population is not associated with reductions in maternal and neonatal mortality rates (31-33) with evidence suggesting that rates higher than this may produce negative health outcomes for both women and babies (32). Although it is reported that caesarean sections are being performed excessively, there is evidence that caesarean sections are underused in some settings or among some groups of women and overused in others (28).

Using data that includes 98.4% of the world's births, the Lancet Series '*Optimising caesarean section use'* (2018) reported variation in caesarean section rates between countries, within countries,

between healthcare sectors, and between wealth quintiles (28). For example, 0.6% of women in South Sudan have a caesarean section compared to 63% of women in Egypt. Between provinces in China, the caesarean section rates vary from 4% to 62%. When comparing the rate of caesarean section between the public and private sector, in low and middle-income countries there are 1.8 times the odds that women in the private sector will have a caesarean section compared to women in the public sector. Additionally, women in the wealthiest quintile have almost 5 times the amount of caesarean sections compared to women in the poorest quintiles, which means that overuse can be present in low, middle and high-income countries (28).

Global data on other obstetric interventions such as instrumental vaginal delivery (forceps or vacuum), induction of labour, episiotomy, and epidural are not as well compiled as caesarean sections. However, similarly, variation between settings exists. In low and middle-income countries, the percentage of hospitals that perform instrumental vaginal deliveries in Africa ranges from 2% in Burkina Faso to 51% in Eritrea (34). In high-income countries, the rate can vary from 4.5% in the United States (35) to 15% in the United Kingdom (UK) (36). The global incidence of labour induction has also continued to rise (37). In some settings, induction of labour and episiotomy are performed routinely, and without clinical indication (28, 38, 39). Epidurals are also becoming increasingly common as a form of analgesia to relieve pain during labour (40). Epidural analgesia rates vary around the world from around 2% in African nations (41) and up to 83% in parts of Europe (42). There is a general decreasing trend in episiotomy use, however, it is still practiced extensively, particularly in low-income countries (43). The rate varies widely between countries from as low as 5% in Denmark, and up to 75% in Cyprus (44) and 100% in Taiwan (45). The wide variation in episiotomy use is likely attributable to differences in policies, which can include either the routine or selective use of episiotomy (46).

Variation in use itself is not necessarily negative, it can be positive if the variation reflects health services responding to differences in patient preferences or underlying health care needs (47). To some extent, variation in health care should always exist due to the uniqueness of individuals receiving care. The key is to identify unnecessary variation - which could be a reflection of professional uncertainty over treatment options, professional behavioural styles (aggressive versus conservative) and/or hospital culture - whilst preserving necessary variation to ensure that care is patient-centred (48). When there is substantial variation in the use of a particular treatment or procedure, it is necessary to investigate whether appropriate care is being delivered. When a difference in the use of health services does not reflect differences in patient preferences and healthcare needs, this is considered to be unwarranted variation and it presents as an opportunity for the health system to improve.

Inequities in maternity care: a national perspective

In Australia, 303,029 babies were born in 2018 (7). Although maternal mortality is a relatively rare event in Australia (6 deaths per 100,000 women giving birth), the national rate does not reveal the inequities in maternal mortality between groups of women. Due to the ongoing colonisation and its impacts on the First Nations peoples of Australia, First Nations women have a higher incidence of maternal mortality (26.5 deaths per 100,000 women) compared to non-First Nations women (5.5 deaths per 100,000 women) (10). In remote and very remote regions of Australia, there are 9.4 maternal deaths per 100,000 women compared to 5.8 maternal deaths per 100,000 women giving birth in major cities (10). Similarly, unequal access to maternity care services exists in Australia, with First Nations women, those living in rural and remote areas, and those experiencing socioeconomic disadvantage having reduced utilisation of antenatal care services (7).

Similar to the global trend, Australia has also experienced an increase in the use of all obstetric interventions and a decrease in non-instrumental vaginal births. The rate of caesarean section has increased from 25% in 2000 (8) to 35% in 2018 (7). There has also been an increase in the number of women who have their labour induced from 26% in 2000 (8) to 34% in 2018 (7). The rate of non-instrumental vaginal births has decreased while instrumental vaginal births have increased (49) from 11.2% in 2007 (forceps 3.6% and vacuum 7.5%) (50) to 18% in 2017 (forceps 8% and vacuum 11%) (51). Unlike many other countries, in Australia, the rate of episiotomy has increased from 12% in 2000 (52) to 23% in 2019 (7). For primiparous women, the rate is 75.2% (49). Australia has a policy of selective use of episiotomy, so, in comparison to countries with similar policies such as Denmark, which has an episiotomy rate of 5%, the rate of episiotomy in Australia appears to be relatively high (51). Evidence of unequal provision of obstetric interventions exists in Australia, with the *Australian Atlas of Healthcare Variation* series reporting variation in 'caesarean section for selected[2] women' and 'Caesarean sections <39 completed weeks without obstetric or medical indication' between First Nations and non-First Nations women, and between privately funded and publicly funded patients (53, 54).

Supply and demand-side factors that can drive health service provision

Many reasons have been postulated among health practitioners, researchers, and policymakers for the rising rate of interventions. Often, the decision to medically intervene during labour and birth is

[2] Gave birth for the first time over the three-year period 2012–2014; aged 20–34 years; gestational age of baby at birth; 37–41 completed weeks; pregnant with one baby (singleton), and presentation of the baby is vertex (baby's head at the cervix).

due to the clinical or psychological needs of the woman and or baby (55). Commonly, increasing caesarean section rates are attributed to the changing risk profiles of women giving birth such as increasing maternal age and obesity (56-58). When the frequency of use is greater than the frequency of need, other non-clinical factors may be influencing the decision to provide an intervention (59). Demand-side factors relate to the preferences of women can include maternal requests for caesarean section, which is commonly associated with fear of giving birth (60) and previous birth trauma (60). Supply-side factors related to healthcare providers, such as medico-legal concerns (61) and the convenience of providing a caesarean section compared to allowing for the labour and birth to progress naturally (62-64). Other supply-side factors may include those associated with health system and service design and financing mechanisms (65, 66), such as incentives in the form of fee-for-service models (55), and a workforce that is inadequately skilled at managing vaginal births (34, 67).

Health burden associated with obstetric intervention use in labour and birth

Undoubtedly, when medically indicated, obstetric interventions can prevent both maternal and neonatal morbidity and mortality (11, 28, 68). However, the concern for many health practitioners and maternity care consumers around the world is the *overuse* of obstetric interventions, which are those that are performed in the absence of clinical need, for example, in low-risk pregnancies and births (28). Specific concerns surrounding the rising rates of caesarean section are due to the increasing amount of women and babies experiencing morbidity and mortality associated with a medically or surgically intervened birth compared to vaginal birth (11). Although caesarean sections can be a life-saving intervention for women and children in some clinical circumstances, they can also lead to short and long-term psychical and psychological health consequences (11, 69). Like any medical or surgical procedure, induction of labour (37), epidural analgesia (70-74), instrumental vaginal birth (35, 69, 75-79), and episiotomy (80-83) all have the potential to produce negative short and long term health consequences for women and babies and can also create the need for further interventions that again, come with risks to the health of women and babies.

Economic burden of maternity care

The rapidly rising caesarean section rates have raised questions about the economic implications this trend can have on healthcare resources, in comparison to other modes of birth (84). Whilst it may seem discourteous to speak of money when considering healthcare decisions in childbirth, it is an essential consideration to ensure finite healthcare resources are allocated efficiently and equitably and to ensure that the health system delivers universal care. In Australia, the unnecessary use of clinical interventions has been estimated to place a $15 billion economic burden on the health

system funders each year (85, 86). The main funders of Australia's healthcare system – the Federal and State and Territory Governments - have experienced a general trend of increased expenditure in all areas of health. In particular, 'Reproductive and maternal conditions' is one of the highest areas of healthcare expenditure in Australia (87), with a 175% increase in Medicare funding directed at obstetric care over 6 years (88). One Australian study (12) estimated that if excess caesarean sections were reduced to the expected amount within the population based on the population's characteristics (or 'case-mix') (89), that public hospital funders could save $487 million a year.

Not only is there a greater financial burden placed upon healthcare resources with caesarean sections compared to vaginal births (12), there is also a financial burden placed on the consumers of maternity care – women and their families. Australia's health system is a hybrid public-private model. The Australian government provides public universal insurance for basic coverage, known as Medicare, which means that public hospital care is free to all Australian residents and citizens. Individuals also have the option to purchase private insurance for healthcare coverage in addition to Medicare. Private hospitals are owned and operated by the private sector, however, they are licensed and regulated by governments. Most out-of-hospital services, such as medical practices, pharmacies and services that are provided by specialists, are delivered by private providers and come with out-of-pocket costs to individuals. Those who have private health cover and choose to use it can do so as either a private patient in a public hospital or a private patient in a private hospital and some out of hospital services may be partially or fully financially covered under the private insurance scheme, but this depends on the individual policy. Since 1992, there has been an increase in out-of-pocket charges for obstetric care provided under the Medicare Benefits Schedule (MBS) with a 77% increase in costs associated with in-hospital care and a 1,035% increase in costs associated with out-of-hospital care (90). Out-of-pocket costs have been found to be a major barrier for people to access healthcare in Australia (91) and burdensome to the overall household living standards (92).

With an increasing shift towards a more medicalized approach to maternity care, in combination with rising caesarean section rates and the higher costs associated with providing a caesarean in comparison (93) to a vaginal birth to both healthcare funders (12) and maternity care consumers (94), this raises concern about the economic sustainability of the current direction of maternity care in Australia. In addition to the costs associated with the birth event, there is potential for short and long-term sequelae associated with caesarean sections (11), which again, can produce further healthcare costs. Little is known about the long-term economic burden associated with medicalized childbirth. The inefficient use of healthcare funding for one aspect of maternity care can divert finite human and financial resources away from other important areas of maternity care provision such as

primary care services, which consistently receive less government spending compared to hospital services (95). Disproportionate use of healthcare resources as a result of unequal provision of maternity care services could mean that some communities and groups of women and children miss out on other aspects of necessary care.

Thesis rationale

Despite the claim that Australia is 'one of the safest countries in the world in which to give birth or be born' (96), the Australian government has been pushing for maternal healthcare reform for over a decade (88). Additionally, there have been calls from health professionals, researchers, and consumers to improve maternity care services in Australia (97). As with all systems of healthcare and service delivery, there are areas for continued improvement. The call for maternal healthcare reform has been influenced by a lack of access to primary care services; disparities in healthcare practice between the public and private sector and between institutions; inequalities in health outcomes, with poorer health outcomes disproportionately experienced by vulnerable groups of women and babies; the health and economic burden associated with rising rates of obstetric interventions, and the need to revise funding mechanisms (97). However, maternal healthcare reform in Australia is widely debated and highly contentious and has seen a lack of overarching direction and establishment of measurable outcomes.

In Australia, the rates of obstetric intervention are more than what is considered optimal within a population (49). Evidence suggests that intervention rates this high may not produce benefits to the population and may cause harm (32). With evidence of disparate health outcomes experienced by women and babies, the overuse of costly medical interventions could mean that there are fewer resources available for other areas of maternity care, and potentially, some groups of women and babies may miss out on necessary care. Examination of the factors contributing to the provision of caesarean sections is essential to ensure that clinical care is being targeted towards those for whom it is clinically necessary and so women and babies who require care, receive it. Various government reports demonstrate that in Australia, there is a distortion in the supply, access, and equity of maternity care services that disproportionately affect vulnerable groups of women and children (7, 88). Both supply and demand factors can influence how resources are distributed, how health services behave, and ultimately how care is delivered, influencing the healthcare experience and health outcomes of women and babies. The WHO has stated that maternal characteristics are not entirely responsible for the high rates of caesarean sections currently being experienced and that factors related to all levels of the health system can influence the delivery of care (98). Taking the general view that Australia is a safe country to have a baby, may conceal whether appropriate care is

being provided and whether disparities exist in the provision of care between communities and sub-population groups and whether the financing mechanisms are equitable and efficient.

Each health system is unique, and thus far, there has not been a comprehensive examination of the distribution of maternity care services and the driving factors of medical intervention during labour and birth at various levels of the health system (including public and private) in Australia. Understanding the current trends of maternity care coverage and the driving forces behind the provision of services can:

- provide insight enabling critical reflection of current health policies and practices and the potential levers of change at various levels of the health system
- help to determine who in the population is missing out on services and resources
- provide insight into the various incentives that occur during the clinical encounter that may drive overuse and/or underuse of maternity care

Such information can be used:

- to ensure that medical care is being provided appropriately and equitably
- to help address unmet healthcare needs
- for planning and implementing maternal health policy to ensure that services are sustainable
- to ensure that maternal health reform moves in its intended direction of improving access and equity for all women and children in Australia.

Aim

The overarching aim of this thesis is to gain an in-depth understanding of the patterns of maternity health service use among the population, and drivers of trends in the use of maternal healthcare from various levels of the health system. To address this aim, this thesis will answer the following questions:

Research questions:

1. Does variation in maternal health care and service provision exist between subpopulation groups and hospital and health service jurisdictions in Queensland, Australia?
2. What are the clinical drivers and health provider reasons for providing caesarean sections in Queensland public and private hospitals?

3. In what ways have macro-level health and economic policies influenced the management of maternal health care in Australia

Thesis structure

This thesis contains nine chapters organised into five sections. Below is an outline and a brief description of the sections and chapters within the thesis. Six of the nine chapters within the thesis contain peer-reviewed articles that have been published or are under review in peer review journals. A full list of publications contained within this thesis is listed on page ix. The thesis structure and the chapters with corresponding publications are also presented at the beginning of each section of the thesis.

Section 1: Introduction and methods (Chapters 1 and 2).

Section 1 contains two unpublished chapters. Chapter one (this Chapter) provides a background on the contemporary management of childbirth, and global and national trends of maternal health care provision, service coverage, and health outcomes for women and children. It has covered the thesis rationale, the overarching aim, and the research questions. Chapter 2 contains a description of the dataset used in this thesis, including the data linkage methods, data security, ethics approvals, and study setting.

Section 2: Inequities in maternal health service provision (Chapters 3, 4, and 5).

Section 2 contains two published analytical chapters and one which is under review. Section two addresses research question 1 of the thesis. The focus of this section is examining whether variation exists in maternal health care provision and health service coverage between population groups and hospital and health service jurisdictions in Queensland. Chapter 3 – published in *BMC Pregnancy and Childbirth* – examines variation in obstetric interventions between different ethnic, geographical, and socioeconomic groups of women in Queensland. Chapter 4 – under review with the *International Journal of Health Planning and Policy* – examines variation in the provision of primary care services during the perinatal period between different ethnic, geographical, and socioeconomic groups of women in Queensland. Chapter 5 – published in *Australian Health Review* – examines variation in the provision of obstetric interventions between hospital and health service jurisdictions in Queensland.

Section 3: A case study of the driving factors behind caesarean sections in Queensland hospitals (Chapters 6 and 7).

Section three of this thesis contains one published analytical chapter and one which is under review. It also contains two supplementary files including a Letter to the Editor that was received in response to the original article, alongside our response to the Letter to the Editor. Section three

addresses research question 2 of the thesis. The focus of this section is to examine the clinician recorded reasons for primary caesarean section provision in public and private hospitals to better understand what is driving the provision of caesarean sections in Queensland. Chapter 6 – published in *Birth* – focuses on the factors driving caesarean sections in Queensland public hospitals. Chapter 7 – under review in *Midwifery* – focuses on the factors driving caesarean sections in Queensland private hospitals.

Section 4: Macro-level healthcare financing policy levers of maternal health care (Chapter 8).

Section four contains one published chapter, chapter 8 published in *BMC Public Health,* which is a scoping review and synthesis of the macro-level healthcare financing mechanisms and their influence on the trends of maternal health care provision that are described in sections 2 and 3 of the thesis.

Section 5: Discussion and conclusion (Chapter 9).

The final section of the thesis presents a synthesis of the main findings of the thesis, alongside recommendations for policy, practice, and future research. The strengths and limitations of the methods used in this thesis are also described in this section

Chapter 2: Methods

The detailed methods and statistical analysis for each separate study will be outlined in their respective chapters. This methods section is to provide an overarching understanding of the data linkage, data security, study setting, and ethics approvals used for the Ph.D. thesis.

Data

This thesis used a population-level, linked administrative healthcare and cost dataset, and is situated within a large maternal and child health data linkage project (99). The larger maternal and child health project contains various studies, which predominantly use economic methodologies and modelling to examine:

- health service use associated with childbearing and early childhood
- health system costs of childbearing and early childhood
- out-of-pocket healthcare costs associated with childbearing and early childhood
- inequities in health service use and out-of-pocket costs between different subpopulations including high and low socioeconomic status, rural and remote and Aboriginal and Torres Strait Islander populations.

The studies conducted under the broader maternal and child health project demonstrate the economic impacts of the current delivery of maternal health services in Australia; the cost of different models of maternity care; inequities in health system and patient costs associated with accessing maternal health services, and the economic impact of the increasing medicalisation of childbirth. These studies compliment the studies conducted in this thesis as they demonstrate the financial impact both to the health system and mothers of variation in maternal health care and increasing medicalised care.

The linked dataset contains all women who gave birth in Queensland between 1 July 2012 and 30 June 2015 (n=186,789), plus their resultant babies (n= 189,909), including follow-up health service use data until 30 June 2016. These dates were chosen for this thesis as this was the most recent, available data at the time of data extraction and linkage. This dataset will be continuously updated over time as more data becomes available. Within the linked dataset are the following individual datasets, which contain data from 1 July 2012 to 30 June 2016:

- Perinatal Data Collection (PDC)
- Queensland Hospital Admitted Patient Data Collection (QHAPDC)
- Emergency Department Information System (EDIS)

- Registrar General Births
- Registrar General Deaths
- Hospital and Health Service Funding and Costing Unit records
- Medicare Benefits Schedule (MBS) data collection
- Pharmaceutical Benefits Scheme (PBS) data collection

The PDC collects information on all births that take place in Queensland and includes the data items relating to the woman including factors relating to the pregnancy, labour, and birth, and also the data items relating to the baby. The PDC is completed by midwives and other staff, using information obtained from mothers and hospital or other records. This core set of data elements is agreed to and progressed by the National Perinatal Data Development Committee (NPDDC) and endorsed by the National Health Information Standards and Statistics Committee (NHISSC). The quality of information produced from the QPDC depends on the accuracy, consistency and timeliness of the completion of the forms. Completed forms and electronic extracts are validated and queries relating to missing, contradictory, or ambiguous data are directed back to the hospital or independent practitioner (100).

The QHAPDC collects demographic data and clinical information on all admitted patients separated from both public and licensed private hospitals and private day surgeries in Queensland. A separation can be a formal separation (including discharge, transfer or death) or a statistical separation (episode type changes). For Hospital and Health Services (HHSs), reporting to the QHAPDC is a requirement under their Service Agreement. Public hospitals are required to submit data electronically using an approved file format. At Queensland Health, when a patient is admitted to hospital, they are assigned a Unit Record (U.R) number and this means they are an admitted patient. Once admitted, the patient is then cared for by a health practitioner or team of practitioners (doctor, and/or nurse and/or midwife). The health practitioners electronically enter the details of the patient (including diagnosis, care provided, medications given) in Integrated Electronic Medical Records (ieMR). Approximately one month after separation (discharge, transfer or death), clinical coders within Queensland Health go through all of the patient notes in ieMR and assign diagnosis codes based on the most relevant edition of the International Statistical Classification of Diseases and Related Health Problems Australian Modification (ICD-10-AM) (101).

The EDIS contains records of each presentation at Emergency Departments across Queensland. EDIS is an online ‘real-time’ system with data entry reflected immediately, allowing it to be used to manage patient flow in the ED.

The MBS data collection contains information on services that qualify for a benefit under the Health Insurance Act 1973 and for which a claim has been processed, including benefits paid, patients, and service providers. MBS claims data are an administrative by-product of the Department of Human Services administration of the Medicare fee-for-service payment system. The PBS data collection contains information on prescription medicines that qualify for a benefit under the National Health Act 1953 and for which a claim has been processed. The PBS database comprises information about PBS scripts and payments, patients, prescribers, and dispensing pharmacies. PBS claims data are an administrative by-product of the Department of Human Services administration of the subsidised prescription payment system.

Data extraction and linkage process

Queensland Health's Statistical Services Branch (SSB) identified women from the Queensland PDC who gave birth between 1 July 2012 and 30 June 2015. The SSB also identified the woman's resultant babies who were born during this time period. The SSB then linked both the woman's and baby's PDC records to their QHAPDC, Registrar General Deaths, Registrar General Births, EDIS, and Hospital and Health Service Funding and Costing Unit Records between 1 July 2012 to 30 June 2016. Once the records were linked, the SSB removed the identifying information and deposited the de-identified data into SURE (Secure Unified Research Environment) for the researchers.

An identifying dataset containing names, dates of birth, and addresses, plus study identification number was transferred from the Queensland Health SSB to the Australian Institute of Health and Welfare (AIHW). The AIHW linked the Queensland Health records to the relevant MBS and PBS records for the study time period of 1 July 2012 to 30 June 2015. The following data items obtained from the Queensland PDC were provided by the SSB to the AIHW to be linked: Mother's identifier, Mother's name, mother's date of birth, mother's address, baby's identifier, baby's name, baby's date of birth.

When a record linked with an MBS or PBS claim record between 01 July 2012 and 30 June 2016, the AIHW provided the researchers with the following (de-identified data): MBS data: Date of service, Medicare item number, provider charge, patient out of pocket cost, rendering provider postcode, hospital indicator, patient postcode. PBS data: Date of supply, PBS item code, patient category, patient contribution, net benefit, pharmacy postcode, patient postcode. If the data was unable to be linked, then these records were not included in the final linked dataset. For all records that were linked to MBS and PBS records, the AIHW removed all identifying information and deposited the de-identified data into SURE for the researchers.

Data storage and security and confidentiality

All personal identifiers were removed from the dataset following the data linkage process and instead, a unique patient identifier was created by the AIHW to be able to link mothers with their babies and to link individuals across the different datasets. The data is stored in a highly secure virtual project workspace within SURE (Secure Unified Research Environment). The data within SURE cannot be copied, downloaded, or transmitted by email or other means. Researchers can take their analysed results from SURE, but no original data can leave SURE. All inputs and outcomes are vetted through a unique curated gateway, whereby all transactions are monitored.

Statistical software used

The softwares' that were used to conduct the analyses in this thesis include:

- SAS® 9.4 statistical software
- System for Automated Geoscientific Analysis (SAGA GIS) (2.3.2)

Ethical approvals

This project was conducted in accordance with the National Health and Medical Research Council (NHMRC) National Statement on Ethical Conduct in Human Research, 2007 (102). This thesis is part of a larger project '*Health economics of early childhood and maternal health: using data linkage to identify health service use, and health system and patient costs*'. The larger project received human research ethics approval from the Townsville Hospital and Health Service Human Research Ethics Committee (HREC) (HREC/16/QTHS/223) on 1 November 2016, James Cook University HREC (H7246) on 28 November 2017, and the Australian Institute of Health and Welfare HREC (EO2017-1-338) on 27 May 2017. We also received Public Health Act Approval (RD007377) on 10 April 2017 to waive consent for data collection. No identifiable patient information was provided to the authors.

Section 2: Inequities in maternal health service provision

This section of the thesis addresses research question number 1 of the thesis: *Does variation in maternity care exist between subpopulation groups and hospital and health service jurisdictions in Queensland, Australia?* Section two contains three published papers. In chapter 3, variation in the provision of obstetric interventions is examined between socioeconomic, ethnic, and geographic groups in Queensland. In chapter 4, variation in maternal health service coverage is examined between socioeconomic, ethnic, and geographic groups of women in Queensland. In chapter 5, variation in the provision of obstetric interventions is examined between Hospital and Health Service jurisdictions in Queensland.

The publications included in this section of the thesis include:

- **Fox H,** Callander E, Lindsay D, Topp S. Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers. *BMC Pregnancy and Childbirth.* 2019;19(1):226. DOI: https://doi.org/10.1186/s12884-019-2369-5
- **Fox, H**., Topp, S., Lindsay, D., Callander, E. Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia. *International Journal of Health Planning and Management*.. 2021. DOI: https://doi.org/10.1002/hpm.3277
- **Fox, H**., Callander, E., Lindsay, D., Topp, S. Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals. *Australian Health Review*. 2021. DOI: https://doi.org/10.1071/AH20014.

Section 1: Introduction and methods

Chapter one: Introduction

Chapter two: Methods

Section 2: Inequities in maternal health service provision

Chapter three: Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers

Fox H, Callander E, Lindsay D, Topp S. Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers. *BMC Pregnancy and Childbirth*. 2019;19(1):226. DOI: https://doi.org/10.1186/s12884-019-2369-5

Chapter four: Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia.

Fox H, Topp S, Lindsay D, Callander E. Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia. *International Journal of Health Planning and management*.. 2021. DOI: https://doi.org/10.1002/hpm.3277

Chapter five: Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals.

Fox H, Callander E, Lindsay D, Topp S. Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals. *Australian Health Review*.2021; DOI: https://doi.org/10.1071/AH20014

Research question 1

Section 3: A case study of the determinants of caesarean section provision in Queensland hospitals.

Chapter six: A cascade of interventions: determinants of caesarean sections in Australian public hospitals.

Fox H, Topp S, Lindsay D, Callander E. A cascade of interventions: determinants of caesarean sections in Australian public hospitals. *Birth.* 2021. DOI: https://doi.org/10.1111/birt.12530

Chapter seven: Drivers of primary caesarean sections in Australian private hospitals..

Fox H, Topp S, Lindsay D, Callander E. Determinants of caesarean sections in Australian private hospitals. *Midwifery*. Under review. 2021.

Research question 2

Section 4: Macro-level healthcare financing policy levers of maternal health care

Chapter eight: A review of the impact of financing mechanisms on maternal health care in Australia

Fox H, Topp SM, Callander E, Lindsay D. A review of the impact of financing mechanisms on maternal health care in Australia. BMC public health. 2019;19(1):1540. DOI: https://doi.org/10.1186/s12889-019-7850-6

Research question 3

Section 5: Discussion and conclusion

Chapter nine: Discussion and conclusion

CHAPTER 3: Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers

Abstract

Background:

There is global concern for the overuse of obstetric interventions during labour and birth. Of particular concern is the increasing amount of mothers and babies experiencing morbidity and mortality associated with caesarean section compared to vaginal birth. In high-income settings, emerging evidence suggests that overuse of obstetric intervention is more prevalent among wealthier mothers with no medical need of it. In Australia, the rates of caesarean section and other obstetric interventions are rising. These rising rates of intervention have been mirrored by a decreasing rate of unassisted non-instrumental vaginal deliveries. In the context of rising global concern about rising caesarean section rates and the known health effects of caesarean section on mothers and children, we aim to better characterise the use of obstetric intervention in the state of Queensland, Australia by examining the characteristics of mothers receiving an obstetric intervention. Identifying whether there is overuse of obstetric interventions within a population is critical to improving the quality, value and appropriateness of maternity care.

Methods:

The association between demographic characteristics (at birth) and birth delivery type were compared with chi-square. The percentage of mothers based on their socioeconomic characteristics were reported and differences in percentages of obstetric interventions were compared. Multivariate analysis was undertaken using multiple logistic regression to assess the likelihood of receiving an obstetric intervention and having a vaginal (non-instrumental) delivery after accounting for key clinical characteristics.

Results:

Non-Indigenous mothers, mothers in major cities and mothers in the wealthiest quintile all had higher percentages of all obstetric interventions and had the lowest percentages of unassisted (non-instrumental) vaginal births. These differences remained even after adjusting for other key sociodemographic and clinical characteristics. Indigenous mothers had a higher percentage of unassisted vaginal births (67.8%) compared to non-indigenous mothers (55.3%). Mothers in the highest wealth quintile had a lower percentage of unassisted vaginal births (50.5%) compared to mothers in the lowest wealth quintile (62.1%). The logistic regression model also supported these findings with mothers in IRSD1, IRSD2 and IRSD 4 were respectively 0.07, 0.05 and 0.12 times less

likely to have a caesarean section than mothers in the most wealthy IRSD5. Mothers living in inner regional areas were 0.06 times less likely to have a caesarean section than mother living in major cities.

Conclusions:

Differences in obstetric practice exist between economic, ethnic and geographical groups of mothers that are not attributable to medical or lifestyle risk factors. These differences may reflect health system, organisational and structural conditions and therefore, a better understanding of the non-clinical factors that influence the supply and demand of obstetric interventions is required.

Introduction

Obstetric interventions such as caesarean section can be life-saving for mothers and newborns when medically indicated (28). Underuse of such interventions – often stemming from lack of physical access to skilled care – has been the focus of substantial research, policy and advocacy efforts. But overuse of obstetric interventions is now an emerging global concern. The recent Lancet series 'Optimising Caesarean Section Use' reported a doubling in the global rate of caesarean birth in the past 15 years to 21% (28), when population rates above 10-15% are considered excessive (31, 32).

Not all attempted vaginal births result in a vaginal birth and the use of obstetric interventions during labour and birth in an adequately resourced health facility with appropriately trained staff can be effective for preventing perinatal morbidity and mortality (28). For example, a caesarean section may be necessary when a vaginal delivery poses a risk to the woman or baby and when complications arise in circumstances such as fetal distress, abnormal fetal presentation, antepartum haemorrhage and hypertensive disease (11, 68). In low-income settings where mothers have limited access to caesarean sections, the data has shown an increased risk of death for both mother and baby (103). Because of this, the underuse of obstetric interventions including caesarean sections has been a major focus of literature, research, policy and funding efforts for several decades in the strive to reduce perinatal morbidity and mortality (55).

However, more recent attention has been given to the increasing evidence of *overuse* of obstetric interventions in some settings (28, 30). Particular concerns surrounding the rising rates of caesarean section have emerged due to the increasing amount of mothers and babies experiencing morbidity and mortality associated with caesarean section compared to vaginal birth (11). In the short term, and compared to mothers who have a vaginal birth, mothers who have a caesarean section are at higher risk of haemorrhage requiring a hysterectomy, uterine rupture, complications associated with anaesthetic, renal failure, obstetric shock, cardiac arrest, venous thromboembolism, and major puerperal infection (11, 104-106). In the long term, mothers who have a caesarean section have an increased risk of experiencing pelvic adhesions (107), bowel obstruction (108), future subfertility (109, 110), decreased satisfaction with the birth, lower rates of breastfeeding and less positive reactions to their baby after birth (111) compared to those who have a vaginal birth. In subsequent births following caesarean section mothers are more likely to experience preterm birth and stillbirth (110, 112) and maternal death due to increased risk of uterine rupture (11).

Mothers who need obstetric care and do not receive it are faced with the risk of poor maternal health outcomes. At the same time, mothers and babies who receive unnecessary obstetric interventions are at an increased risk of iatrogenic consequences –in the short and long-term. Both

the underuse and overuse of obstetric intervention – sometimes termed 'too little too late too much too soon' - have thus been identified as issues of global concern (26). A related set of concerns, pertaining to the inequities implicit in the current known patterns of under and overuse. In many countries, for example, it is the poorest mothers who have inadequate access to necessary and potentially life-saving obstetric interventions (28). While across low-, middle- and high-income settings emerging evidence suggests that overuse of obstetric intervention is more prevalent among wealthier mothers with no medical need of it (28).

In Australia, the rate of caesarean section is currently 34% (2016) and expected to continue increasing over time (113). Concurrently, there has been a rise in the use of other obstetric interventions such as induction of labour, instrumental vaginal birth (vacuum and forceps), and episiotomy (114). These rising rates of intervention have been mirrored by a decreasing rate of unassisted non-instrumental vaginal deliveries (114). In the context of rising global concern about rising caesarean section rates, we aim to better characterise the use of obstetric intervention in the state of Queensland, Australia with an explicit focus on the 'user' side. That is, the characteristics of mothers receiving obstetric intervention.

Background of maternal and child health in Queensland

Queensland has a population of approximately 4 million, spread across a total land area of 1,852,642 square kilometres, some seven times the size of Great Britain. More than half of the state's population lives outside the urban south-east pocket of the greater Brisbane metropolitan area, a comparatively high proportion compared to other (more urbanised) Australian states (22). In Queensland in 2015, 60,942 mothers gave birth to 61,903 babies, which includes 3,931 women who identified as Aboriginal and/or Torres Strait Islander and their 3,979 babies. In Queensland, the Maternal Mortality Ratio (MMR) was 7.3 per 100,000 births and the perinatal mortality rate was 9.8 per 1,000 births, this includes 6.7 stillbirths and 3.1 neonatal deaths per 1,000 births (2015) (115). These rates are not significantly different from the national figures (113). Whilst caesarean section is considered to contribute to the low levels of mortality, there is also the view that obstetric intervention rates are higher than desirable (97). In Queensland in 2015, 34% of women had a caesarean section (116) and 22.5% had an instrumental birth (with either vacuum or forceps) (114).

Access to maternal health services

Within Australia overall, reproductive health services are accessed in the first instance via a network of General Practitioners whereby mothers are advised to book in at their closest hospital that has maternity services available. The individual health service and different availability of maternal models of care determine the type of care that a mother receives during her perinatal journey (97).

In Queensland, the four main options of maternity care models include Midwifery Group Practice caseload care, private midwifery care, private obstetrician (specialist) care, and shared care, which is delivered by a combination of GP, doctors and midwives within the community and a public hospital (117). Access to these maternity models of care depends on the services provided within each public Hospital and Health Service.

In Australia, there is a public universal healthcare system known as Medicare. Women are entitled to access their maternity care in public hospitals free of charge. However, it is also possible for women to hold private health insurance and some may choose to access care in private hospitals. Women may choose to receive private maternity care as it gives them continuity of care from a chosen obstetrician throughout pregnancy and birth. It is known, however, that women who birth privately do have higher rates of interventions (114).

Aims

In order to better characterise the use of obstetric intervention state-wide, this study will address the following questions:

1. What are the socioeconomic characteristics of mothers who receive obstetric interventions during labour and birth?
2. What is the likelihood of having an obstetric intervention by Aboriginal and/or Torres Strait Islander status, socio-economic status and geographic status? The primary outcome of interest is a caesarean section. Secondary outcomes are instrumental vaginal birth; vaginal (non-instrumental) birth; the induction of labour; episiotomy; and epidural.

Methods

Data

This project utilised a whole of population linked dataset called Maternity1000 (99). Maternity1000 utilises the Queensland Perinatal Data Collection (PDC) to identify all mothers who gave birth in Queensland, and currently contains the records of mothers who gave birth between 1 July 2012 and 30 June 2015 (n=186,789), plus their resultant babies (n= 189,909).

All individuals were identified from the Queensland Perinatal Data Collection and Queensland Birth Registry by Queensland Health's Statistical Services Branch (SSB). The records were then linked to Queensland Hospital Admitted Patient Data Collection (QHAPDC), Deaths Registry, Emergency Department Information System (EDIS) and Hospital and Health Service (HHS) Funding and Costing

Unit records between 1 July 2012 and 30 June 2015. The records were then linked by the Australian Institute of Health and Welfare (AIHW) to Medicare Benefits Schedule (MBS) and Pharmaceutical Benefits Scheme (PBS) claims records (99). However, only the data from the PDC was utilised in this study.

Index of Relative Socioeconomic Disadvantage

Our study uses the Index of Relative Socioeconomic Disadvantage (IRSD) to categorise mothers into levels of socioeconomic position based upon their postcode of residence at the time of birth. The IRSD is compiled by the Australian Bureau of Statistics (ABS) and represents 'the socioeconomic conditions of Australian geographic areas by measuring aspects of disadvantage' (118). It is designed to work like a scoring system where the attributes of populations, such as income, level of educational attainment and employment status are summarised to produce a score. Our study collapsed the IRSD decile rank into five categories (IRSD1-5). IRSD1 is the lowest socioeconomic group, which represents individuals in the study population that are living in areas with the lowest socioeconomic conditions. Conversely, IRSD5 is the highest socioeconomic group, which represents individuals in the study population that are living in areas with the highest socioeconomic conditions (118).

Mother's rurality

To categorise mothers into levels of rurality, our study used the Accessibility/Remoteness Index of Australia (ARIA+) that was developed by the Australian Bureau of Statistics (119) to categorise women based upon their postcode of residence at the time of birth. The index scores have been classified into the following categories:

1. Major Cities — relatively unrestricted access to a wide range of goods, services and opportunities for social interaction.

2. Inner Regional — some restrictions to access to some goods, services and opportunities for social interaction.

3. Outer Regional — significantly restricted access to goods, services and opportunities for social interaction.

4. Remote — very restricted access to goods, services and opportunities for social interaction.

5. Very Remote — very little access to goods, services and opportunities for social interaction (119).

Indigenous status

Mothers that identified at antenatal visits as either Aboriginal and/or Torres Strait Islander were recorded on the Queensland Perinatal Data Collection. In this paper, those mothers who responded 'yes' as either Aboriginal and/or Torres Strait Islander will be referred to as 'Indigenous' and those who identified as not being either Aboriginal and/or Torres Strait Islander will be referred to as 'non-Indigenous'.

Outcome variables

The primary outcome for this study was mothers giving birth via caesarean section. Secondary outcomes were modes of birth: instrumental vaginal birth and vaginal (non-instrumental) birth, and obstetric interventions during labour and birth: induction of labour; episiotomy; and epidural.

Statistical analysis

The frequency and percentage of mothers who gave birth in Queensland between 1 July 2012 and 30 June 2015 were reported by IRSD, level of rurality, Indigenous status, previous pregnancy, pre-existing medical condition, plurality, and smoking status. The mean age and Body Mass Index (BMI) were also reported (Table 3.1). Figures on the same characteristics of mothers from the entire Australian population are also summarised in Table 3.1 to demonstrate the similarities and differences between the Queensland population and the Australian population. These figures were sourced from the Australian Institute of Health and Welfare (AIHW) annual *Australia's mothers and babies* (2012-2015) reports (120-123).

The association between demographic characteristics (at birth) and birth delivery type were compared with chi-square analyses. Due to the large sample size, we reported the Cramer's V effect size value to determine the strengths of association between the population groups. Cramer's V values were interpreted as per Cohen (1998) (124). The percentage of mothers that identified as Indigenous, different levels of rurality and IRSD quintiles were reported and differences in percentages of obstetric interventions were compared. Multivariate analysis was then undertaken using multiple logistic regression to assess the likelihood of receiving obstetric intervention and having an unassisted (non-instrumental) vaginal delivery. The Odds Ratios (ORs) were calculated with adjustment for the mother having a pre-existing health condition, maternal age, previous pregnancy complications, complications arising during the current pregnancy, obesity, area-based socioeconomic deprivation, distance from the birthing facility, and smoking as potential confounding variables (125, 126). All analysis was undertaken using SAS9.4 statistical software.

Results

There were 189,811 babies born to mothers in Queensland between 1 July 2012 and 30 June 2015. Table 3.1 summarises the maternal characteristics of the mothers giving birth (both in Queensland and nationally) including the Index of Relative Socioeconomic Disposition (IRSD), rurality, Indigenous status, previous pregnancy, plurality, smoking status, and the mean age and Body Mass Index (BMI). Just over one-quarter of mothers (27%) in Queensland were in the highest socio-economic quintile while 9.92% and 20.86% respectively were in the two lower quintiles. Nationally, the percentage of mothers in the middle IRSD quintiles were similar to Queensland, with the greatest differences being in the highest and lowest socio-economic quintiles (18% and 22% respectively for the national population). Six percent of Queensland mothers identified as Indigenous, which is slightly greater than the Australian population at large (4%). Matching national population profiles, almost 70% of Queensland mothers had a previous pregnancy, the average age of mothers was 30 and BMI at birth was 26.6. Queensland has a less urbanised population than the Australian population (50.22% compared to 71% living in major cities), with a greater percentage of mothers living in outer regional areas in Queensland (20.57%) compared to the national population (9%).

Table 3.1: Maternal characteristics for mothers who gave birth in Queensland and Australia between 1 July 2012 and 30 June 2015– *AIHW 2012-2015*

	Queensland	**Australia**
Maternal characteristics	n=189,811 (%)	n=918,539 (%)
IRSD[3]		
IRSD5 (least disadvantaged)	50,663 (26.99)	164,227 (18)
IRSD4	43,278 (23.05)	181,973 (20)
IRSD3	35,997 (19.18)	181,764 (20)
IRSD2	39,165 (20.86)	180,589 (20)
IRSD1 (most disadvantaged)	18,625 (9.92)	191,402 (22)
Rurality		
Major city	94,285 (50.22)	654,273 (71)
Inner regional	35,341 (18.83)	150,269 (17)
Outer regional	38,610 (20.57)	79,040 (9)
Remote	12,286 (6.54)	13,868 (2)
Very remote	7,206 (3.84)	9,162 (1)

[3] Index of Relative Socioeconomic Disadvantage, with IRSD1 being women who live in the lowest socioeconomic conditions and IRSD 5 being the women who live in the highest socioeconomic conditions.

Indigenous status		
No	178,133 (93.8)	879,306 (96)
Yes	11,668 (6.2)	37,849 (4)
Previous pregnancy		
No	57,392 (30.24)	397215.5 (34)
Yes	132,414 (69.76)	609864.5 (66)
Pre-existing medical condition		
No	142,096 (74.86)	740,343 (81)
Yes	47,703 (25.14)	178,196 (19)
Plurality		
Singleton	183,832 (96.85)	904.634 (98)
Twins	5,792 (3.05)	12,124 (1.5)
Triplets and Quadruplets	187 (0.10)	1,763 (.5)
Smoking status		
No	163,337 (86.53)	744,727 (81)
Yes	25,568 (13.47)	173,813 (19)
Age (mean)	29.9	30.1
BMI (mean)	26.6	26.2

As seen in Table 3.2, Indigenous mothers had a higher percentage of unassisted vaginal births and a lower percentage of all other intervention types compared to non-Indigenous mothers. Instrumental vaginal births, episiotomies, epidurals and caesarean sections generally decreased with increasing rurality. All interventions generally increased with increasing socioeconomic status. All of the Cramer's V effect sizes are <0.1 and therefore indicate a small effect size.

Table 3.2: Sociodemographic characteristics of mothers receiving obstetric intervention during labour and birth in Queensland between 01/07/2012 and 30/06/2015, n (percentage %).

	Caesarean section	Instrumental vaginal birth	Vaginal (non-instrumental) birth	Induction of labour	Episiotomy	Epidural
Indigenous	3,057 (26.2)	701 (6.0)	7,911 (67.8)	2,544 (21.8)	456 (3.9)	1,167 (10.0)
Non-Indigenous	61,278 (34.4)	18,348 (10.3)	98,508 (55.3)	43,999 (24.7)	12,113 (6.8)	28,858(16.2)
Cramer's V	*0.0417****	*0.0342****	*0.0605****	*0.0160****	*0.0282****	*0.0407****
Major city	33,660 (35.7)	10,654 (11.3)	50,065 (53.1)	23,194 (24.6)	7,261 (7.7)	16,971 (18.0)
Inner regional	11,309 (32.0)	3,251 (9.2)	20,745 (58.7)	8,588 (24.3)	2,014 (5.7)	5,275 (16.2)
Outer regional	12,278 (31.8)	3,359 (8.7)	22,972 (59.5)	9,382 (24.3)	2,201 (5.7)	5,097 (13.2)
Remote	4,018 (32.7)	995 (8.1)	7,286 (59.3)	2,961 (24.1)	700 (5.7)	1,290 (10.5)
Very remote	2,212 (30.7)	562 (7.8)	4,432 (61.5)	1,845 (25.6)	354 (4.9)	670 (9.3)
Cramer's V	*0.0404****	*0.0431****	*0.0640****	*0.0064*	*0.0417****	*0.0744****
IRSD[4] 1	5,625 (30.2)	1,434 (7.7)	11,566 (62.1)	4,191 (22.5)	875 (4.7)	1,974 (10.6)
IRSD 2	12,533 (32.0)	3,447 (8.8)	23,186 (59.2)	9,439 (24.1)	2,193 (5.6)	5,523 (14.1)
IRSD 3	12,347 (34.3)	3,456 (9.6)	20,194 (56.1)	8,495 (23.6)	2,304 (6.4)	6,011 (16.7)
IRSD 4	13,936 (32.2)	4,371 (10.1)	24,928 (57.6)	10,776 (24.9)	2,640 (6.1)	7,011 (16.2)

[4] Index of Relative Socioeconomic Disadvantage, with IRSD1 being women who live in the lowest socioeconomic conditions and IRSD 5 being the women who live in the highest socioeconomic conditions.

IRSD 5	18,987 (37.5)	6,076 (12.0)	25,570 (50.5)	13,063 (25.8)	4,506 (8.9)	11,646 (23.0)
Cramer's V	*0.0528****	*0.0470****	*0.0772****	*0.0245****	*0.0574****	*0.0611****

*Note: significance levels are determined by Chi-square analyses. Cramer's V values are reported due to the large sample size. *p sig at .05 **p sig at .01. ***p sig at .001.*

Table 3.3 shows the adjusted odds of obstetric intervention based on socioeconomic characteristics, after accounting for key clinical characteristics[v]. Indigenous mothers were 0.06 times less likely to have a caesarean section than non-Indigenous mothers. Similarly, mothers in IRSD1, IRSD2 and IRSD 4 were respectively 0.07, 0.05 and 0.12 times less likely to have a caesarean section than mothers in the most wealthy IRSD5. Mothers living in inner regional areas were 0.06 times less likely to have a caesarean section than mother living in major cities.

Indigenous mothers, mothers in inner regional areas, and mothers in all levels of socioeconomic position were all significantly more likely to have a vaginal (non-instrumental) birth than their relevant reference group (Table 3.3). Indigenous mothers, mothers in inner regional, outer regional and very remote regions and mothers in all socioeconomic quintiles were less likely than their relevant reference group to have their labour induced.

Indigenous mothers and mothers from all levels of socioeconomic position were all less likely to have an instrumental vaginal delivery. Indigenous mothers, mothers in inner regional and very remote areas, and mothers from all levels of socioeconomic position were less likely to have an instrumental vaginal delivery. Indigenous mothers and mothers from all levels of rurality and all socioeconomic quintiles were less likely to have an epidural.

Table 3.3: Odds ratios of obstetric interventions, adjusted for a pre-existing health condition, maternal age, previous pregnancy complications, complications arising during the current pregnancy, area-based socioeconomic deprivation, distance from the birthing facility, smoking and BMI at birth for mothers in Queensland

	Caesarean section		Instrumental vaginal birth		Vaginal (non-instrumental) birth		Induction of labour		Episiotomy		Epidural	
	OR	95% CI	OR	95%CI	OR	95% CI	OR	95% CI	OR	95%CI	OR	95%CI

Indigenous	*0.94*	*0.90 – 0.99*	*0.70*	*0.65 - 0.77*	*1.14*	*1.09 - 1.19*	*0.86*	*0.82 - 0.90*	*n/a* [5]	*0.65 - 0.80*	*0.74*	*0.69 - 0.79*
Inner Regional	*0.96*	*0.93 – 0.99*	*0.92*	*0.88 – 0.97*	*1.06*	*1.03 – 1.09*	*1.10*	*1.10 - 1.13*	*0.89*	*0.84- 0.95*	*0.98*	*0.94 – 1.02*
Outer Regional	*1.03*	*1.00 - 1.06*	*0.87*	*0.83 - 0.91*	*1.01*	*0.9- 1.0.4*	*1.10*	*1.07 - 1.14*	*0.94*	*0.89 - 1.00*	*0.79*	*0.76 - 0.82*
Remote	*1.10*	*1.05 - 1.15*	*0.77*	*0.72 - 0.83*	*1.00*	*0.96 - 1.04*	*1.05*	*1.00- 1.10*	*0.88*	*0.80 – 0.95*	*0.57*	*0.54 - 0.61*
Very remote	*1.00*	*0.95 - 1.10*	*0.85*	*0.77 - 0.94*	*1.05*	*0.99 - 1.11*	*1.20*	*1.17- 1.32*	*0.85*	*0.76 – 0.96*	*0.605*	*0.55 - 0.66*
IRSD[6] 1	*0.93*	*0.89 – 0.97*	*0.80*	*0.75 – 0.86*	*1.15*	*1.10- 1.20*	*0.79*	*0.75- 0.83*	*0.63*	*0.58- 0.69*	*0.72*	*0.68 - 0.77*
IRSD 2	*0.95*	*0.92 – 0.98*	*0.85*	*0.81 - 0.89*	*1.11*	*1.08 -1.14*	*0.91*	*0.88- 0.94*	*0.70*	*0.66 - 0.74*	*0.90*	*0.86 - 0.94*
IRSD 3	*0.99*	*0.96 - 1.03*	*0.90*	*0.85 - 0.94*	*1.04*	*1.01- 1.08*	*0.84*	*0.81- 0.87*	*0.80*	*0.75- 0.85*	*0.96*	*0.92 – 1.00*
IRSD 4	*0.88*	*0.85 - 0.90*	*0.93*	*0.89 – 0.97*	*1.15*	*1.12 - 1.19*	*0.95*	*0.81 – 0.87*	*0.72*	*0.75 - 0.85*	*1.01*	*0.97 – 1.10*

Discussion

The aim of this study was to examine the likelihood of receiving obstetric interventions during labour and birth based on Indigenous, socio-economic and geographic status. Non-Indigenous mothers,

[5] The sample size was too low to produce a result for the odds ratio

[6] Index of Relative Socioeconomic Disadvantage, with IRSD1 being women who live in the lowest socioeconomic conditions and IRSD 5 being the women who live in the highest socioeconomic conditions.

mothers in major cities and mothers in the wealthiest quintile all had higher percentages of all obstetric interventions and had the lowest percentages of vaginal (non-instrumental) births. These differences remained even after adjusting for other key socio-economic, demographic and clinical characteristics.

Prima facie, we would expect the percentage of obstetric interventions to be higher among population groups with known higher rates of maternal risk factors. In Australia, Indigenous mothers, mothers from socioeconomically disadvantaged backgrounds and mothers residing in rural and remote regions attend fewer antenatal appointments (113), experience higher rates of smoking during pregnancy (114), are more likely to be obese and have a higher prevalence of pre-existing medical conditions such as hypertension, diabetes and gestational diabetes (113). These factors are all associated with increased risk during pregnancy and birth and increase the potential need for obstetric intervention (113, 127-130).

Our adjusted figures, however, demonstrate the pattern of intervention in Queensland to be the inverse of these expectations with mothers in the wealthiest quintile having significantly higher odds of having a caesarean section, induction, episiotomy, epidural and instrumental vaginal birth than mothers in the poorest quintile. Even after adjusting for known clinical risk factors, the likelihood that wealthier, non-Indigenous, urban-based mothers received obstetric intervention remained significant. Given the relatively high intervention rates in Australia, these results are strongly suggestive of a pattern of overuse, as has been demonstrated in other countries (28).

The analysis presented here does not enable us to assess whether mothers from geographically, economically or ethnically marginalised groups are receiving too few interventions. However, evidence from the literature suggests that caesarean section levels above 10-15% do not reduce maternal or perinatal mortality rates within a population (2, 3), with all groups of mothers reported in our study having caesarean section rates well above this. Our results do raise the urgent question as to why wealthier, urban, and non-Indigenous mothers are receiving such relatively high rates of obstetric intervention, even after adjusting for medical and lifestyle risk factors?

Variation in obstetric intervention rates has been reported globally between geographic regions, between wealth quintiles (26, 28, 131) between states and territories within countries (114), between public and private hospitals (132), between different ethnic groups (133), and between hospitals (134). Boatin et al. (135) examined differences in caesarean section rates between wealth quintiles in 72 low and middle-income countries, which found that overall, caesarean section rates were lower amongst the poorest wealth quintile and higher among the richest wealth quintile, with only three European countries having higher caesarean section rates in the poorest fifth than the

richest fifth. The results of their study are comparable to ours, which found significantly higher caesarean section rates among the least disadvantaged quintile compared to the most disadvantaged quintile

Little systematic work has been done to capture Australian mothers' preferences regarding birth and obstetric intervention, although one study conducted in 2007 suggests that few mothers want a caesarean section in the absence of a clinical need for it (136). Some pregnant mothers may choose, or agree to birth via Caesarean section due to non-medical factors. Fear of birth (137-141), previous birth experience (137, 141), concerns about the safety of a vaginal delivery (142), health provider influence (136, 137, 143, 144), misinformation (137, 143), and social norms and expectations (145, 146) may all play a part in the decision to have a caesarean delivery. In Australia, 24% of pregnant mothers experience fear of birth (147), with multiple Australian studies (139, 140, 148) reporting a greater likelihood of having a caesarean section for mothers who experience fear of childbirth during pregnancy. Consideration should also be given to the influence that care providers may have on a woman's decision to have a caesarean section (149, 150). Currently, there is a lack of research that reports on the interactions between women and their care providers and the information provided to women when they choose to have a caesarean birth. One Australian study (41) that surveyed pregnant women on their recollection of discussions with health providers on the risks and benefits of caesarean section for themselves and their baby reported that women who preferred to have a caesarean section were typically poorly informed about the associated risks for themselves and their baby.

The clinical outcome data that was utilised in this study is routinely collected across Australia (99). The strength of these data sources are the ability to generate results for an entire population, as opposed to a selected sample, and also the completeness of Indigenous status identification. This reduces the potential for sampling bias, as it does not limit the sample size of mothers from minority population groups that are often underrepresented in healthcare research (151). However, the limitations of this study are the measure of socioeconomic disadvantage is area-based and not measured at the individual level. Additionally, clinical outcomes are not woman-centered, which means that such measures do not directly capture whether the outcomes of importance to birthing women are met.

Conclusion

This study has demonstrated that differences in obstetric practice exist between economic, ethnic and geographical groups of mothers that are not attributable to medical or lifestyle risk factors in Queensland, Australia. Rather, differences may reflect health system, organisational and structural

conditions. To deliver maternity care that is equitable and of high quality, there needs to be a systems thinking approach to better understand the non-clinical factors that influence the supply and demand of obstetric interventions. Serious consideration at the government, organisational and health provider level of how to reduce the potentially inappropriate use of obstetric interventions and the consequential iatrogenic conditions that can result from unwarranted use is essential.

Chapter 4: Ethnic, Socioeconomic and geographic inequities in maternal health service coverage in Australia

Introduction

Australia is a high-income country with a universal health care system and is considered to have one of the highest levels of mother and child health and well-being in the world (152). However, due to the ongoing colonization and dispossession of Australia's First Nations peoples, striking health disparities exist in pregnancy and birth outcomes between First Nations and non-First Nations mothers and babies (153). This is reflected in First Nations mothers and babies, in addition to non-urban dwelling, and socioeconomically disadvantaged mothers and babies, having an increased likelihood of experiencing perinatal morbidity and mortality (10, 154). Evidence from several states in Australia has identified that the majority of perinatal morbidity and mortality is due to modifiable antenatal factors. These may be increasingly prevalent among certain populations due to a failure of mainstream health approaches to deliver care that is appropriate, accessible and meets the needs of all mothers (8, 155). Such factors include smoking, infection, maternal nutrition, and psychosocial stress (156, 157), with cardiovascular conditions and suicide the leading cause of maternal death in Australia (10).

If cardiovascular conditions are not managed effectively, there can be a significant health burden for mothers and an increased likelihood that adverse fetal outcomes will be experienced (158). Similarly, for mothers with untreated diabetes during pregnancy, there is a higher risk of poor outcomes such as miscarriage, preterm birth and an increased likelihood of medical or surgical intervention during birth (159-161), with access to timely and appropriate medical treatment known to reduce adverse birth outcomes (162). With the second leading cause of maternal death in Australia being suicide (10), recognising mental health conditions and ensuring that women receive appropriate support is essential to prevent the potentially devastating consequences for women and their families. In high-resource settings, it is estimated that approximately 20% of maternal deaths are attributed to women who - often as a result of the way systems are designed and administered - fail to receive adequate care during the antenatal period, with many of these women belonging to marginalised groups and living in areas of socioeconomic deprivation (163). It cannot be assumed that standardised service delivery, which is designed upon clinical safety (164), can meet the needs of diverse groups of women they are created to serve. The aim of this study is to determine whether there are disparities in health service utilisation (including antenatal care) between socioeconomic, geographic and ethnic groups of mothers who experience hypertension, diabetes and mental health conditions.

Improving maternal health outcomes is not only dependent on improving the socioeconomic conditions in which people live (165) but on designing care services that are sensitive to these socioeconomic conditions and thus acceptable and accessible for women. The evidence is clear that adequate and timely access to quality, woman-centred health services delivered by skilled health practitioners throughout pregnancy, birth and the postpartum period are known to reduce maternal and neonatal morbidity and mortality, with notable reductions among women who are experiencing poor health (166-170). In particular, Antenatal Care (ANC) is a vital opportunity for health providers to detect and manage other health conditions and risk factors that may complicate pregnancy and birth such as hypertension, diabetes, malnutrition, obesity, mental illness, and alcohol, tobacco and drug use. Antenatal care is also an opportunity to reduce the likelihood of disease in adult life for the child, given the recognised link between in-utero and early-life health and chronic disease (171-173). Due to this, the World Health Organization (WHO) and the Australian Department of Health (DoH) both recommend that women commence antenatal care in the first trimester of pregnancy and attend at least 8 antenatal care appointments (166, 174).

Improving access to maternity care services for First Nations, rural and remote and socioeconomically disadvantaged mothers has been on the national agenda in Australia for over a decade (97), demonstrating an interest in providing equitable and adequate care for all women. However, little change has been seen in the maternity care setting in terms of *how* care is delivered and there remains evidence of inequitable maternal health service provision at the population level (153, 154, 175). Disparities in health service use exist in many sectors of Australia's health system (5), particularly affecting the most vulnerable people in the population, who are typically those with the greatest healthcare needs. This trend has been termed the 'inverse care law', which states that the availability of good medical care tends to vary inversely with the need for it in the population served (176). Those who have the greatest need for healthcare often, paradoxically, utilise health services less frequently than those who have fewer healthcare needs. Inequitable health service coverage can result in unmet healthcare needs, inequitable health outcomes and financial burden to both individuals and the health system due to the worsening health status of people whose medical conditions go untreated (177). Understanding patterns of health service coverage is critical for acknowledging the underlying, systemic drivers including racialized practices that inhibit the uptake of health services for certain population groups (178). Further, such understanding helps to prioritise and organise maternal health services in a way that gives all mothers and babies access to timely and effective treatment and care, whilst at the same time providing insight for how to allocate finite resources rationally and evidence-based.

Several studies (179, 180) and Government reports (97, 154) have examined access to maternity care services in Australia. However, to the best of our knowledge, this is the first study to compare utilisation of health services for mothers with specific pregnancy risk factors. The methods used to report differences in health service utilisation in this study are:

1. The percentage of pregnant women with health conditions who utilised maternity care services, including antenatal care; chronic disease management and mental health care during the perinatal period by socioeconomic, geographic and First Nations status.
2. For women who did access and utilise chronic disease management and mental health services, the average number of services utilised by women based on socioeconomic, geographic and Indigenous status.

The results of this study will allow for better identification of the inequities in health service provision for pregnant mothers with maternal health conditions, and to highlight the flaws within our health system to provide guidance for systemic reform to ensure that the health system meets the needs of all mothers and babies.

Methods

Data

The project utilises a linked administrative dataset (99) called Maternity1000, which was constructed using the Queensland Perinatal Data Collection (QPDC) to identify all mothers who gave birth in Queensland between 2012 and 2015 (n=186,789), plus their resultant babies (n= 189,909). The records were linked by Queensland Health Statistical Services Branch (SSB) to Queensland Hospital Admitted Patient Data Collection (QHAPDC), Deaths Registry, Emergency Department Information System (EDIS) and Hospital and Health Service (HHS) Funding and Costing Unit records by Queensland Health Statistical Services Branch (SSB). These records were then linked by the Australian Institute of Health and Welfare (AIHW) to Medicare Benefits Schedule (MBS) and Pharmaceutical Benefits Scheme (PBS) claims records for the time period of the study. In this present study, we utilised the Perinatal Data Collection and the Medicare Benefits Schedule datasets.

Ethics approvals and patient consent

Ethics approval was obtained from the Townsville Hospital and Health Service Human Research Ethics Committee (HREC) (HREC/16/QTHS/223), James Cook University HREC (H7246) and the

Australian Institute of Health and Welfare HREC (EO2017-1-338). We also received Public Health Act Approval (RD007377) to waive consent for data collection.

Socioeconomic and demographic characteristics

To categorise mothers into different levels of socioeconomic position, our study uses the Index of Relative Socioeconomic Disadvantage (IRSD), which is based upon their postcode of residence at the time of birth. The IRSD is compiled by the Australian Bureau of Statistics (ABS) and represents 'the socioeconomic conditions of Australian geographic areas by measuring aspects of disadvantage' (118). Our study collapsed the IRSD rank into quartiles (IRSD1-4). IRSD1 is the lowest socioeconomic group, which represents individuals in the study population who are living in the lowest socioeconomic conditions. Conversely, IRSD4 is the highest socioeconomic group, which represents individuals in the study population who are living in the highest socioeconomic conditions (118). To categorise mothers into levels of rurality, our study used the Accessibility/Remoteness Index of Australia (ARIA+) that was developed by the ABS (119) to categorise women based upon their postcode of residence at the time of birth. Mothers who identified at antenatal visits as either Aboriginal and/or Torres Strait Islander were recorded on the Queensland Perinatal Data Collection. We have adopted the nomenclature recommended by the 'Uluru Statement from the Heart' (2017) (181). In this paper, those mothers who responded 'yes' as either Aboriginal and/or Torres Strait Islander will be referred to as 'First Nations' and those who identified as not being either Aboriginal and/or Torres Strait Islander will be referred to as 'non-First Nations'.

Health conditions during pregnancy

To classify mothers by health conditions that were recorded by a health practitioner with a diagnosis during the time period of the study (2012-2015), we used the International Statistical Classification of Diseases and Related Health Problems, Ninth Revision, Australian Modification (ICD-10AM 9th edition) (182). Please refer to Appendix 1 for the classification of mental health diagnoses, hypertension and diabetes, which were examined in this study.

Outcome measures - health service utilisation

The outcomes of interest for this study were specific health services that mothers accessed during the perinatal period. Due to the opportunity that health providers have during antenatal care to help prevent and manage health conditions, we chose to examine antenatal care attendance. Antenatal care attendance was recorded on the Perinatal Data Collection dataset including the gestational week that antenatal care was commenced, which we categorized as either first trimester; second

trimester or third trimester, and how many antenatal care appointments were attended, which we categorised as less than 2; 2 to 4; 5 to 7 and 8 or more.

The Department of Health assigns item numbers to all Medicare services subsidised by the Australian Government. We used these item numbers, which are available on 'Medicare Online' (183), to place mothers in categories of attendance at a health service for the following health services: referral to a psychologist; attendance at a psychologist; psychological support from a General Practitioner and chronic disease management provided by a medical practitioner (see Appendix 1).

Statistical analysis

To determine the differences in risk factors between population groups, the association between demographic characteristics and maternal health risk factors were compared with chi-square analyses. To compare antenatal care utilisation between population groups we included all mothers within the dataset. When comparing attendances at mental health services we limited the population to all mothers who had a mental health diagnosis. When comparing attendances at chronic disease management appointments we limited the population to all mothers who had a diagnosis of hypertension during pregnancy or diabetes (either gestational or pre-existing).

Multivariate analyses were undertaken using multiple logistic regression to assess the likelihood of attending health services. A separate model was constructed for each outcome including antenatal care appointments (less than 2, 2-4, 5-7 and 8 or more); commencement of antenatal care (first trimester, second trimester and third trimester); referral to a psychologist; attendance at a psychologist; attendance at a GP for psychological care; chronic disease management for hypertension and chronic disease management for diabetes. We present the Odds Ratios (ORs) and 95% Confidence Intervals (CI).

To compare the differences in the number of services accessed between groups of mothers, generalised linear regression modelling was conducted. A separate model was constructed for each outcome measure. In order to identify the number of services accessed by mothers from birth through to the time their baby was one year of age, the number of events were identified on the MBS dataset. For the analyses, we adjusted for age and Body Mass Index (BMI) as they were initially found to have a significant effect on the outcomes of interest, and therefore should be included in the final models. Variables such as marital and education status do not exist in the Maternity1000 dataset and therefore, we were unable to account for their influence in this study.

Results

There were 189,811 babies born to mothers in Queensland between 2012 and 2015. As seen in Table 4.1, almost half (45.7%) of all First Nations mothers smoked during pregnancy, which was more than 4 times the average smoking rate among Queensland mothers. Rural and remote mothers had a significantly higher percentage of smoking during pregnancy (19%) compared to urban mothers (9.6%). Mothers in the lowest socioeconomic quartile (most disadvantaged) had a higher percentage of smoking during pregnancy (25.6%) compared to mothers in the highest socioeconomic quartile (6.4%).

First Nations mothers were almost twice as likely to be classified as underweight during pregnancy (11.3%) compared to non-First Nation mothers (6.4%). Further, First Nations mothers had a significantly higher percentage of obesity (6.6%) compared to non-First Nations mothers (4.8%). Rural and remote mothers had significantly higher rates of obesity (6.3%) compared to urban mothers (3.2) and mothers in the lowest socioeconomic quartile had a higher percentage of obesity (7%) compared to mothers in the highest socioeconomic quartile (3.3%).

First Nations mothers had a significantly higher percentage of pre-existing diabetes (5.1%) compared to non-First Nations mothers (3.6%). Rural and remote mothers had a significantly higher percentage of pre-existing diabetes (4.5%); and gestational diabetes (6.1%) compared to urban (3.5% and 5.4%) and regional mothers (3.8% and 5.3%). Mothers in the lowest socioeconomic quartile had a significantly higher percentage of pre-existing diabetes (4.8%) compared to mothers in the highest socioeconomic quartile (3.6%).

Table 4.1. Number (%) of women with antenatal risk factors by socioeconomic and demographic characteristics

	Smoking during pregnancy	***Underweight*** [7]	***Overweight and obese*** [8]	***Hypertensive disorders of pregnancy***	***Pre-existing diabetes***	***Gestational diabetes***	***Mental Health diagnosis*** [9]
Total n (%)	*24,938 (13.4)*	*12,556 (6.7)*	*9,206 (4.9)*	*5,193 (2.8)*	*7,000 (3.7)*	*10,248 (5.5)*	*8,669 (4.6)*
First-Nation's Status - n (%)							

[7] Body Mass Index under 18.5
[8] Body Mass Index greater than 25
[9] Either anxiety, depression, bipolar, schizophrenia

First Nations	*4,395 (45.7)*	*1,305 (11.3)*	*759 (6.6)*	*271 (2.8)*	*495 (5.1)*	*522 (5.4)*	*583 (5)*
Non-First Nations	*17,917 (11.4)*	*11,248 (6.4)*	*8,447 (4.8)*	*4,285 (2.7)*	*5,668 (3.6)*	*8,525 (5.4)*	*8,086 (4.6)*
Cramer's V (p value)	*0.23 (<.0001)*	*0.04 (<.0001)*	*0.02 (<.0001)*	*0.01 (0.663)*	*0.18 (<.0001)*	*0.03 (0.900)*	*0.05 (0.03)*
Geographic region - n (%)							
Urban	*8,007 (9.6)*	*6,421 (6.9)*	*3,874 (4.2)*	*2,324 (2.8)*	*2,929 (3.5)*	*4,524 (5.4)*	*5,027 (5.4)*
Regional	*10,906 (17.0)*	*4,758 (6.5)*	*4,026 (5.6)*	*1,735 (2.7)*	*2,422 (3.8)*	*3,428 (5.3)*	*3,104 (4.2)*
Rural and remote	*3,164 (19.0)*	*1,217 (6.3)*	*1,209 (6.3)*	*418 (2.5)*	*746 (4.5)*	*1,019 (6.1)*	*490 (2.6)*
Cramer's V (p value)	*0.11 (<.0001)*	*0.01 (<.0001)*	*0.03 (<.0001)*	*0.04 (0.191)*	*0.15 (<.0001)*	*0.010 (.0001)*	*0.04 (<.0001)*
Socioeconomic position – n (%)							
IRSD[10] 1 – most disadvantaged	*2,693 (25.6)*	*841 (7.0)*	*846 (7.0)*	*249 (2.4)*	*505 (4.8)*	*643 (6.1)*	*457 (3.8)*
IRSD 2	*1,199 (5.4)*	*454 (7.2)*	*363 (5.8)*	*138 (2.5)*	*201 (3.7)*	*299 (5.5)*	*329 (5.2)*
IRSD 3	*15,310 (14.8)*	*7,504 (6.4)*	*6,264 (5.4)*	*2,896 (2.8)*	*3,775 (3.6)*	*5,517 (5.3)*	*6,187 (5.3)*
IRSD 4 – least disadvantaged	*2,875 (6.4)*	*3,597 (7.2)*	*1,636 (3.3)*	*1,194 (2.6)*	*1,616 (3.6)*	*2,512 (5.5)*	*1,648 (3.3)*
Cramer's V (p value)	*0.15 (<.0001)*	*0.01 (<.0001)*	*0.05 (<.0001)*	*0.007 (0.033)*	*0.15 (<.0001)*	*0.09 (0.003)*	*0.04 (<.0001)*

Higher percentage than the Queensland average	*Lower percentage than the Queensland average*

[10] Index of Relative Socioeconomic Disadvantage, with IRSD1 being women who live in the lowest socioeconomic conditions and IRSD 5 being the women who live in the highest socioeconomic conditions.

First Nations mothers commenced antenatal care later in pregnancy (Figure 4.2) and attended fewer antenatal care appointments (Figure 4.1) and after adjusting for socioeconomic and demographic characteristics, First Nations mothers are significantly less likely to attend 8 or more antenatal care appointments (Table 4.2) and significantly less likely to commence antenatal care in the first trimester compared to non-First Nations mothers. Fewer mothers in IRSD 1 (most disadvantaged) attended more than 8 antenatal care appointments and commenced antenatal care in the first trimester. Mothers in the IRSD1, IRSD2 and IRSD3 were all significantly less likely to attend more than 8 antenatal care appointments and significantly less likely to commence antenatal care in the first trimester compared to mothers in IRSD4.

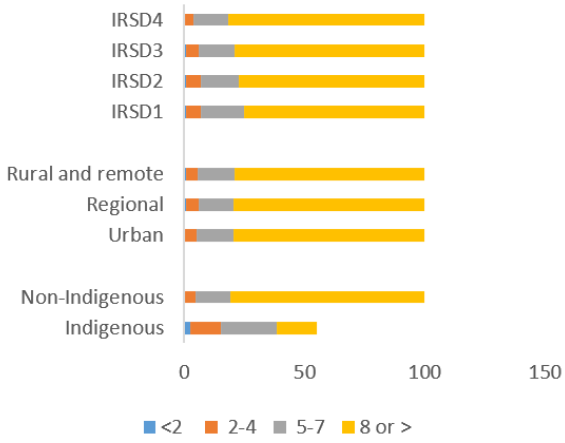

Figure 4.1: Percentage of women that attended antenatal care appointments by socioeconomic and demographic characteristics, 2012-2015.

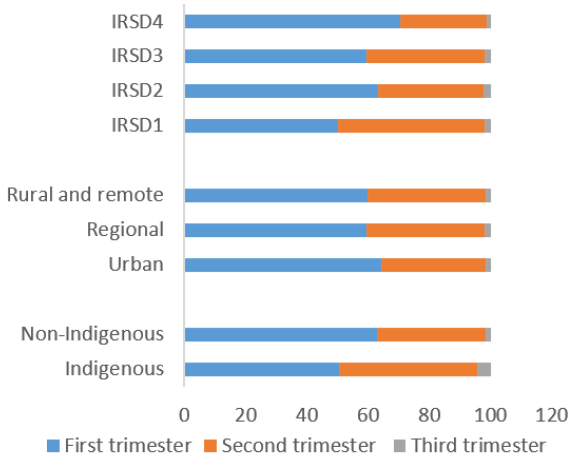

Figure 4.2: Percentage of women and their commencement of antenatal care by socioeconomic and demographic characteristics, 2012-2015

Fewer First Nations mothers with a mental health diagnosis received psychological support from a GP; received a referral from a GP to a psychologist and attended a psychologist (Figure 4.3) and were significantly less likely to receive psychological support from a psychologist compared to non-First Nations mothers (Table 4.3). Fewer rural and remote mothers with a mental health diagnosis received psychological support from a GP and referral to a psychologist compared to regional and urban mothers. Fewer regional, rural, and remote mothers with a mental health diagnosis received support from a psychologist. Rural and remote mothers with a mental health diagnosis were significantly less likely to receive psychological support from a GP and support from a psychologist than urban mothers. Fewer mothers in IRSD1 with a mental health diagnosis received support from a psychologist. Mothers in IRSD1 and IRSD2 were significantly less likely to receive care from a psychologist compared to mothers in IRSD4.

A higher percentage of First Nation mothers with diabetes or hypertension received chronic disease management from a medical practitioner (Figure 4.4). Fewer regional, rural, and remote mothers

with diabetes or hypertension received chronic disease management from a medical practitioner compared to urban mothers. Fewer mothers in IRSD1 with a diabetes diagnosis received chronic disease management for diabetes compared to mothers in the higher socioeconomic levels (least disadvantaged).

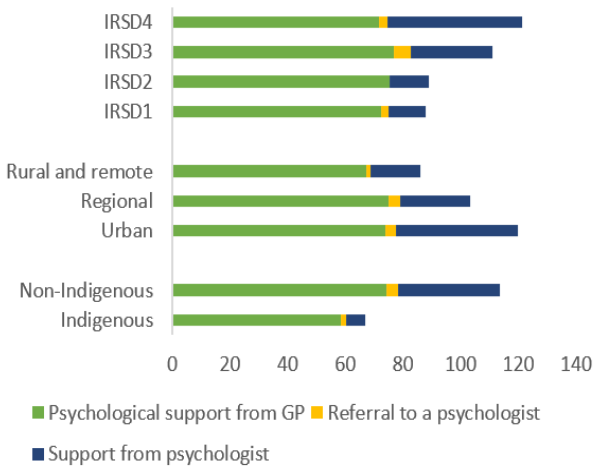

Figure 4.3: Percentage of women with a mental health diagnosis that received mental health care by socioeconomic and demographic characteristics, 2012-2015.

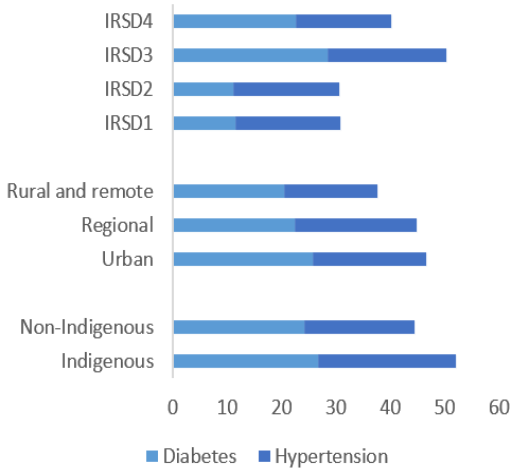

Figure 4.4: Percentage of women with diabetes and hypertension that received chronic disease care by socioeconomic and demographic characteristics, 2012-2015.

Table 4.2. Adjusted Odds Ratio of access to health services for mothers with risk factors by socioeconomic and demographic characteristics, OR (95% CI).

	ANC visits <2	ANC visits 2-4	ANC visits 5-7	ANC visits >8	ANC started in first trimester	ANC started in second trimester	ANC started in third trimester	Psychological support from GP	Referral to psychologist	Psychologist	Chronic Disease Management - DM	Chronic Disease Management - HTN
First nations	*4.9 (4.1-5.8)**	3.2 (3.0-3.4)*	1.8 (1.7-1.9)*	0.4 (0.3-0.41)*	0.7 (0.65-0.71)*	*1.3 (1.2-1.32)**	*2.53 (2.24-2.85)**	*1.14 (1.08-1.21)**	*0.7 (0.5-0.9)**	*0.6 (0.5-0.7)**	*1.4 (1.1-1.7)*	*1.3 (1.0 -1.8)*
Non-First Nations	**REFREENCE GROUP**											
Urban	**REFERENCE GROUP**											
Regional	1.0 (0.8-1.2)	0.81 (0.8-0.9)*	0.82 (0.8-0.87)*	1.2 (1.19-1.3)*	1.1 (1.07-1.12)*	*0.95 (0.93-0.97)*	*0.76 (0.69-0.83)**	*1.11 (1.08-1.15)**	*0.8 (0.4-0.87)**	*0.90 (0.83-0.97)**	*1.0 (0.9-1.1)*	*0.9 (0.7-1.0)*
Rural and remote	0.9 (0.7-1.2)	0.62 (0.6-0.7)*	0.81 (0.8-0.9)*	1.3 (1.25-1.37)*	1.1 (1.10-1.18)*	*0.93 (0.90-0.97)*	*0.61 (0.53-0.71)**	*0.93 (0.87-0.98)**	*0.6 (0.5-0.8)**	*0.5 (0.29-07.8)**	*0.7 (0.6-0.9)*	*0.7 (0.5-0.9)*

IRSD[11] 1	1.4 (1.0-1.2)	1.5 (1.4-1.7)*	1.4 (1.3-1.5)*	0.7 (0.6-0.8)*	0.42 (0.40-0.44)*	*2.3 (2.17-2.4)**	*2.01 (1.67-2.42)**	*0.94 (0.87-1.01)**	*1.25 (1.1-2.1)**	*0.3 (0.24-0.38)**	*1.1 (0.8-1.4)*	*1.3(0.9-1.9)*
IRSD 2	1.6 (1.1-2.3)	1.7(1.5-1.9)*	1.3 (1.2-1.4)*	0.70 (0.65-0.8)*	0.7 (0.6-0.76)*	*1.3 (1.26-1.4)**	*2.15 (1.72-2.70)**	*0.53 (0.49-0.57)**	*0.5 (0.3-0.9)*	*0.63 (0.51-0.78)**	*1.2 (0.8-1.6)*	*1.3 (0.8-2.1)*
IRSD 3	1.6 (1.3-2.0)*	1.5 (1.4-1.6)*	1.1 (1.1-1.2)*	0.8 (0.77-0.82)*	0.60 (0.59-0.62)*	*1.6 (1.55-1.64)**	*1.91 (1.72-2.13)*	*0.82 (0.79-0.85*)*	*1.1 (1.3-1.5)*	*1.49 (1.04-2.13)**	*1.5 (1.3-1.7)*	*1.4 (1.2-1.7)**
IRSD4*	**REFERENCE GROUP**											

*Note: *P value significant at <.0001*

Significantly higher odds ratio than the reference group	*Significantly lower odds ratio than the reference group*

[11] Index of Relative Socioeconomic Disadvantage, with IRSD1 being women who live in the lowest socioeconomic conditions and IRSD 5 being the women who live in the highest socioeconomic conditions.

When comparing the number of services utilised for those who did access care, non-First Nations, regional, and middle-higher socioeconomic mothers accessed the greatest number of services in total. On average, First Nations mothers with a mental health diagnosis attended fewer appointments for psychological support from a GP (2.15±2.79) and psychologist appointments (0.12±0.54) than non-First Nations mothers with a mental health diagnosis (3.65±5.69 and 1.53±2.18, respectively (Table 4.3)). On average, rural and remote mothers with a mental health diagnosis accessed fewer GP services (2.61±3.69) than urban (3.09±3.88) and regional (5.49±9.21) mothers with a mental health diagnosis. Similarly, for psychologist services, rural and remote mothers attended fewer (0.54±1.21) appointments than urban (1.56±2.19) and regional (1.35±2.11) mothers with a mental health diagnosis.

On average, First Nations mothers who accessed chronic disease management attended more appointments for diabetes care (1.24±2.48) and hypertension management (0.71±1.85) than non-First Nations mothers with diabetes (0.71±1.85) and hypertension (0.89±2.10).

Table 4.3. Number of health services accessed for mothers with risk factors by socioeconomic and demographic characteristics

	Number of visits for those who accessed Psychological support from GP, mean, SD	Number of visits for those who accessed Psychological support from psychologist, mean, SD	Number of visits for those who accessed medical practitioner for Chronic Disease Management, HTN, mean, SD	Number of visits for those who accessed medical practitioner for Chronic Disease Management, DM, mean, SD
First Nations status				
First nations	2.6 (3.8)	0.1 (0.5)	1.0 (2.1)	1.2 (2.5)
Non-First Nations	3.7 (4.2)	1.5 (2.2)	0.9 (2.1)	0.7 (1.9)
Geographic region				
Urban	3.6 (3.9)	1.2 (2.2)	0.9 (2.0)	0.7 (1.7)
Regional	5.7 (9.3)	1.1 (2.1)	1.0 (2.2)	0.8 (1.9)
Rural and remote	2.1 (4.1)	0.6 (1.2)	0.7 (1.7)	0.9 (2.6)
Socioeconomic position				

IRSD[12] 1	3.2 (5)	0.7 (2.6)	0.6 (1.5)	0.7 (1.7)
IRSD 2	2.1 (3.1)	0.4 (2)	0.7 (1.7)	0.6 (1.5)
IRSD 3	4.8 (4.2)	1.2 (2.3)	1.0 (2.2)	0.9 (2.1)
IRSD 4	2.2 (3.6)	1.3 (2.0)	0.8 (1.9)	0.5 (1.4)

Discussion

This study aimed to examine whether disparities exist in maternal health service utilisation between socioeconomic, geographic and ethnic groups of mothers who experience health conditions during pregnancy. The results of this study show that there was a broad trend of inequitable health service utilisation, with mothers who experienced the greatest health care needs - First Nations, rural and remote and socioeconomically disadvantaged mothers – being less likely to access health services and in some cases when care was accessed, fewer services being utilised during the perinatal period. Generally, findings showed that non-First Nations, regional, and women in the middle IRSD deciles utilised the most healthcare services. One exception to this general finding was that First Nations mothers with either diabetes or hypertension had greater health service use for chronic disease management than their non-First Nations counterparts.

Some limitations exist in this study. Firstly, the measurement of socioeconomic status is based on postcode and is not at the individual level. A second limitation of this study is that specific services for First Nations peoples, such as Aboriginal Community Controlled Health Organisations (ACCHOs) and dedicated state-funded health services may make use of MBS funding, however, they also have other funding streams and therefore, may not be accurately counted for in MBS data. This is important because this study may have overestimated disparities experienced by First Nations people, who may be having more of their needs met by such services rather than by MBS-related services that we measured in this study. It is still unlikely that these services fully correct such disparities, however, this needs to be considered. Therefore, the MBS findings need more cautious interpretation. It should also be noted that General Practitioners might not always use mental health MBS items for consultations that include a mental health component. A final limitation of this study is that it has only quantified the inequalities that exist between mothers accessing our maternity care system. However, moving forward, it is essential that we address the inequities that cause them, including inequitable policies, and the unequal distribution of power and resources between population groups.

[12] Index of Relative Socioeconomic Disadvantage, with IRSD1 being women who live in the lowest socioeconomic conditions and IRSD 5 being the women who live in the highest socioeconomic conditions.

Our results showed that although First Nations mothers and mothers experiencing socioeconomic disadvantage experience a higher burden of perinatal risk factors, they were less likely to have access to the recommended number of antenatal care appointments and commence antenatal care in the first trimester. When it comes to Australian healthcare policy, First Nations women are not adequately supported. Rather, a long history of paternalistic government decisions have created barriers that actively inhibit the engagement and attendance of First Nations women at maternal health services. For example, even after several decades of consultations with First Nations women requesting access to traditional birthing practices (97, 184-187), these requests continue to be ignored (8). The choice to exclude First Nations women from accessing the care that they need is reflected in the results of our study. Knowing this, a greater commitment to attending to the political levers that exacerbate disparities in maternal healthcare by promoting racialized health policy and service provision is essential for delivering safe, accessible and responsive maternity care services.

The *Rural Maternity Taskforce* reported that the Flying Obstetric and Gynaecology Service has made a significant impact on the delivery of specialist services to the women of outback Queensland (188). And although this study shows a relatively even attendance at antenatal care among geographic regions, when examined at the hospital and health service level, there are small, but an important number of women not accessing maternity services within certain jurisdictions in rural and remote Queensland, which is reflected in the higher rates of poor outcomes among these mothers and babies (188). However, our results do not include Patient Reported Outcomes. What could potentially be judged as quality antenatal care services in rural and remote Queensland from the current limited data view, therefore, may be different from the experience of the mothers accessing these services, and should thus be interpreted with caution.

The second major finding from this study was that although First Nations mothers experience a higher percentage of perinatal mental health conditions, First Nations mothers with a mental health condition were less likely to receive any form of mental health support compared to non-First Nations mothers. Due to structural discrimination within Australia's health system many First Nations peoples living in discrete Indigenous communities have reduced access to mental health services (87). The results of our study found that the highest percentage of perinatal mental health diagnosis was in the second and third IRSD category, which is different from other studies conducted in Australia (189), which show that higher prevalence of mental illness is associated with greater socioeconomic disadvantage, which might be a reflection of potential bias in the QPDC whereby mental health conditions are underreported for socioeconomically disadvantaged women and therefore, their need is even greater than it appears in this study. Further, rural and remote dwelling mothers were less likely to receive any form of mental health support compared to urban mothers,

and socioeconomically disadvantaged mothers were less likely to receive a referral to a psychologist and support from a psychologist. These findings are similar to other studies, which found that MBS spending on mental health was lowest for rural and remote and socioeconomically disadvantaged populations (190, 191). The lack of mental health service coverage is of concern due to the decisions made by the Queensland state government to close more than 130 rural birthing units over a 10 year period (97) forcing First Nations and rural and remote mothers to relocate to give birth 'out of area' or 'off Country', whereby they may be isolated from their families, communities and support networks, further exacerbating the underlying mental health condition. Once mothers return home after giving birth, receiving mental health support may be difficult due to the lack of specialised mental health and support services in these regions (192, 193). When mental health conditions are not identified, and women do not receive adequate support and treatment, there can be far-reaching impacts for the mother, her baby and the entire family (10, 194-198). It is essential that the decision-makers within Australia's health system ensure that no population groups are excluded from receiving specialised, appropriate perinatal mental health care to allow for early detection and treatment to prevent mothers and their families from suffering from potentially devastating consequences associated with perinatal mental illness (199).

The final finding from our study was that mothers experiencing the greatest socioeconomic disadvantage had a higher percentage of both pre-existing and gestational diabetes. However, these mothers accessed fewer chronic disease services than mothers in a higher socioeconomic position. This could be a reflection of the overarching weaknesses of Australia's health system whereby out-of-pocket costs associated with accessing health services create a barrier for people experiencing socioeconomic disadvantage who need care (91). Mothers in rural and remote regions had higher percentages of pre-existing and gestational diabetes but in comparison to their regional and urban counterparts, fewer received chronic disease support from a medical practitioner. In the rural and remote context of Queensland, which is geographically large and has a relatively small population living outside of the metropolitan area, there can be challenges in delivering specialised care in these settings, which is a prevailing issue across all Australia (200). So too is supporting existing health workforces in rural and remote communities a common challenge experienced nationally, with rural and remote healthcare workers typically responsible for providing care across many fields of practice. Our results showed that a higher percentage of First Nations mothers with diabetes and hypertension accessed chronic disease support and accessed more services than non-First Nations mothers. This could be a reflection of both supply and demand-side factors. The improved access in chronic disease care may be a result of the efforts that have been made to improve the service availability and cultural appropriateness of non-communicable disease services over the past

decade, (201-203) in particular the decision to implement these services in collaboration with Aboriginal Community Controlled Organisations (204). In addition, General Practitioners potentially have a better capability of managing chronic diseases by comparison to specialised care for mental health conditions. For First Nations mothers, seeking care for chronic health conditions is potentially associated with less stigma than seeking care for mental health conditions.

Australia's investment in healthcare, including that which is spent on First Nations peoples, is at an all-time high (205). Despite this, the evidence suggests that the way in which the healthcare funds are currently being used to provide maternity care services are ineffective at meeting the needs of many women. Continued investment is required, however, a reconsideration of *how* the funds are used is essential if our maternity care system is to meet the needs of all women. Australia's maternity care system requires a re-design by moving away from a one-size fits-all approach towards a bottom-up approach, whereby women are the architects of health service design and implementation. This would be a step in the right direction towards ensuring the needs of underserved population groups – who the system is currently failing – are being met.

This study has shown that access to healthcare during the perinatal period is a reflection of Australia's general health system strengths and weaknesses, in particular a failure of the government to translate national and state policy intent into acceptable and accessible care in rural and remote areas, for First Nations women and for mothers experiencing socioeconomic disadvantage. Reduced access to primary level health services can result in a worsening health condition, which leads to an increased need for emergency department services or hospitalization, for conditions that can generally be prevented by addressing the socioeconomic and environmental factors that make certain population groups more susceptible. Unmet healthcare needs creates not only a burden on the woman's health but also a burden on already limited health care resources. Investing in the health of mothers and babies is one of the best ways to improve health outcomes and prevent chronic disease throughout life. Appropriate health care during the perinatal period should be accessible to all, irrespective of socioeconomic, ethnic and geographical characteristics. A new maternal health agenda that is more equitable in its commitment to the health for all, rather than the health of most is required.

Chapter 5: Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Queensland hospitals.

Abstract

Objective:

To report on the rates of obstetric interventions within each hospital jurisdiction in the state of Queensland, Australia.

Methods:

This project utilised a whole of population linked dataset that includes health and cost data of all mothers who gave birth in Queensland, Australia, between 2012 and 2015 (n=186,789), plus their resultant babies (n= 189,909). Adjusted and unadjusted rates of obstetric interventions and non-instrumental vaginal delivery were reported within each hospital jurisdiction in Queensland.

Results:

High rates of obstetric intervention exist in both the private and public sector, with higher rates demonstrated in the private sector as compared to the public sector. Within the public sector, there is substantial variation in rates of intervention between Hospital and Health Service jurisdictions after adjusting for confounding variables that influence the need for obstetric intervention.

Conclusions: Due to high rates of obstetric interventions state-wide, a deeper understanding of what factors might be driving these high rates at the health service level, with a focus on the clinical necessity of caesarean section provision is required

Background

Obstetric interventions can be lifesaving for both mothers and babies (28). However, rapidly increasing rates of obstetric intervention in many places over the past two decades have raised concerns about a pattern of overuse (28). Globally, the rate of caesarean section has almost doubled between 2000 and 2015 from 16.0 to 29.7 million (28). The World Health Organization estimates that 6.2 million excess caesarean sections, which are those performed in the absence of clinical need, are performed globally each year (29). To provide a recommendation on an ideal caesarean section rate to the global community, the World Health Organization undertook a systematic review that analysed the association between caesarean section rates and maternal, neonatal and infant outcomes, (32) alongside a worldwide country-level analysis that examined changes in caesarean section rates with corresponding maternal and infant mortality rates over a 30 year period (31). Based upon these combined findings, the World Health Organization has stated that a caesarean section rate higher than 10% at the population level is not associated with reductions in maternal and neonatal mortality rates (33).

In Australia, rates of obstetric intervention have mirrored the global upward trend. The rate of caesarean section in Australia has increased from 25% in 2000 (8) to 34% in 2016 (113). Furthermore, 21% of women in Australia received an episiotomy in 2016 (114), an increase from 12% in 2000 (52). The frequency of labour induction has also increased substantially from 26% in 2000 (8) to 33% in 2017 (51).

Concern regarding the overuse of obstetric intervention stems from both negative health and economic consequences. Evidence demonstrates that when not clinically indicated, obstetric interventions do not always improve outcomes for mothers and babies and can produce negative health consequences well beyond the time of birth (11, 105, 106, 108-112, 206-211). In some settings, induction of labour and episiotomy are performed routinely,(38) and without clinical indication (28, 39, 212). Each medical intervention used during labour and birth creates the possibility of additional risks and adverse outcomes, which has the potential to generate the need for more interventions, which pose their own risk of medical complications for mother and baby (213-217). For example, the use of synthetic oxytocin for the induction of labour can produce outcomes such as uterine tachysystole, subsequent fetal oxygen desaturation (fetal distress) and alterations in fetal heart rate, resulting in the need to deliver the baby more urgently either by an instrumental delivery or emergency caesarean section. (218-220)

Obstetric intervention, particularly caesarean sections are costly to deliver (221) due to its reliance on high-cost specialist staff time, bed day occupation and theatre use. From a health systems

perspective there is an obligation to spend finite health resources efficiently and in a way that most promotes equitable access. With the increasing pressure to deliver the best value care (222, 223), there is a growing interest in Australia to address unwarranted medical practice (224), so that resources are used efficiently, whilst delivering the best possible health outcomes for patients (225). Overuse of obstetric intervention represents a potentially harmful trend for both the health of individual mothers and children and the equitable distribution of health resources at the population level.

In response to the evidence of overuse of caesarean sections and a parallel concern about the potential negative health consequences resulting from unwarranted caesarean section use, the World Health Organization has developed a first of its kind set of guidelines that provides recommendations on non-clinical interventions to reduce unwarranted caesarean sections (30). In Australia, there has been a similar response to the overuse of obstetric intervention with some Australian state Departments of Health developing clinical guidelines that encourage 'normal birth', which is a birth that has not been managed by medical intervention (226, 227). The overuse of obstetric intervention has been identified as an issue in maternal healthcare reform in Australia for over a decade (228-230), with calls at the national level to more effectively monitor the safety, quality, and performance of maternity services across Australia.

Both the Lancet series and the World Health Organization noted that the monitoring and dissemination of caesarean section rates at the hospital level could be a non-clinical intervention that would help reduce their overuse (30, 55). Reporting on obstetric intervention rates at the hospital level, after adjustment for maternal and pregnancy characteristics (case-mix) is important for determining the differences that clinical practice might play in the variation of intervention rates (231). Understanding this variation in care is critical to improving the quality, value and appropriateness of maternal health care. Thus, this study aims to better characterise the use of obstetric interventions in the state of Queensland, Australia with an explicit focus on the provider side. That is, the rate of obstetric interventions provided by each individual hospital jurisdiction in this state.

Aims

In order to better characterise the provision of obstetric interventions at the Hospital and Health Service level in Queensland, this study will address the following question:

1. What is the number of obstetric interventions within each hospital jurisdiction in Queensland? The primary outcome of interest is a caesarean section. Secondary outcomes

are instrumental vaginal birth[13]; non-instrumental vaginal birth[14]; the induction of labour; episiotomy; and epidural analgesia.

Methods

Data

This project utilised a whole of Queensland population linked dataset called Maternity1000 (99). Maternity1000 utilises the Queensland Perinatal Data Collection to identify all women who gave birth in Queensland, and currently contains the records of women who gave birth between 1 July 2012 and 30 June 2015 (n=186,789), plus their resultant babies (n= 189,909). This study forms part of a larger maternal and child health data linkage project (99), which broadly aims to examine health service use and costs associated with childbearing and early childhood in Queensland, Australia. This study specifically seeks to look at the health services being provided to women and the variation across locations, which in turn helps to understand the variation in costs previously observed (233).

All women and babies were identified from the Queensland Perinatal Data Collection and Queensland Birth Registry by Queensland Health's Statistical Services Branch. The records were then linked to Queensland Hospital Admitted Patient Data Collection, Deaths Registry, Emergency Department Information System and Hospital and Health Service Funding and Costing Unit records between 1 July 2012 and 30 June 2015. The records were then linked by the Australian Institute of Health and Welfare to Medicare Benefits Schedule and Pharmaceutical Benefits Scheme claims records (234). In this study, we used the Perinatal Data Collection dataset and the Queensland Hospital Admitted Patient Data Collection dataset. To ensure that the statistics produced are reliable, the Queensland Health Statistical Services Branch undertakes extensive validation checks of the data each month when the data are received, then quarterly, six-monthly and annually. The Statistical Services Branch runs a series of input editing checks on the data to check unusual and incomplete data items. Any potential errors are verified with the hospital contact or practitioner who completed the form. The Perinatal Data Collection dataset is considered of quality for statistical reporting. (235)

Confidentiality and Data Security

All personal identifiers were removed from the dataset following the data linkage process. The research team were not provided with any personally identifiable information on the mothers and

[13] Instrumental vaginal birth is a medically assisted birth with the use of obstetrical instruments – either a vacuum cup or forceps.

[14] 'A birth which is achieved solely by the mother's expulsive efforts requiring no mechanical or surgical assistance' 232. Queensland Health. Queensland Perinatal Data Collection Manual. Brisbane, Australia: Queensland Health, Statistical Services Branch; 2020.

babies within the dataset. The research team is provided with a unique patient identifier created by the Australian Institute of Health and Welfare to be able to link mothers with their babies. The data is stored in a highly secure virtual project workspace within SURE (Secure Unified Research Environment). The data within SURE cannot be copied, downloaded or transmitted by email or other means. Researchers can take their analysed results from SURE, but no original data can leave SURE. All inputs and outcomes are vetted through a unique curated gateway, whereby all transactions are monitored.

Hospital and Health Services

Women and their babies were grouped according to Hospital and Health Service of the hospital they birthed in, which was derived from the Queensland Hospital Admitted Patient Data Collection. Public health services within Queensland Health are provided through 16 Hospital and Health Services (HHS) 'districts', which are situated across the state. Hospital and Health Services are statutory bodies that are independently and locally controlled by a Hospital and Health Board and governed by a Health Service Chief Executive and are responsible for delivering primary, secondary and tertiary health care services to their geographical catchment area. (48)

Outcome variables

The primary outcome for this study was the percentage of mothers giving birth via caesarean section. Please refer to Appendix 1 for a description of how caesarean sections were classified in this study. Additional secondary outcomes of interest were modes of birth: instrumental vaginal birth and non-instrumental vaginal birth, and obstetric interventions during labour and birth: induction of labour; episiotomy; and epidural analgesia. These outcome variables were all derived from the Perinatal Data Collection dataset. Please refer to Appendix 2, which provides a more in-depth description of the methods utilised to conduct the analyses, including variable identification.

Statistical analysis

The frequency and percentage of mothers who gave birth in Queensland Hospital and Health Services between 1 July 2012 and 30 June 2015 were reported by the Index of Relative Socioeconomic Disadvantage, level of rurality and First Nations status. Please refer to 'Supplementary File 1' for details on how these outcomes variables were derived from the dataset.

Initially, the unadjusted percentage of obstetric interventions as a proportion of all births by each Hospital and Health Service were reported. Multivariate analysis was then undertaken using generalised linear models to assess the proportion of women receiving obstetric interventions in each Hospital and Health Service adjusting for a pre-existing health condition, maternal age,

Indigenous status, pregnancy complications, area-based socioeconomic deprivation, rurality, smoking and Body Mass Index at birth (125, 126)

All analysis was undertaken using SAS9.4 software. Please refer to 'Supplementary File 1' for further details of the multivariate analyses including the derivation of coefficients and their statistical effect on the outcomes of interest.

Results

There were 190,728 births in public and private Health Services in Queensland between 1 July 2012 and 30 June 2015. Of those 190,728 births, 46% were in Hospital and Health Services located in metropolitan areas, 24% were in Hospital and Health Services located in regional areas, 2% were in Hospital and Health Services located in rural and remote areas and 28% of babies were born in the private sector (Table 5.1).

Table 5.1 Characteristics of mothers that birthed in Queensland Hospital and Health Services between 01 July 2012 and 30 June 2015, n (%)

Hospital and Health Service	***Deliveries per year (n)***	***Major city %***	***Inner regional%***	***Outer regional%***	***Remote%***	***Very remote%***	***Indigenous%***	***IRSD 1% - most disadvantaged***	***IRSD 2%***	***IRSD 3%***	***IRSD 4%***	***IRSD 5% - least disadvantaged***
Queensland	190,728	96,216 (50.5)	35,829 (18.8)	39,079 (20.5)	12,377 (6.5)	7,227 (3.8)	11,634 (6.1)	18,852 (9.9)	39,651 (20.8)	36,409 (19.1)	43,767 (23)	52,049 (27.3)
Private sector												
Private hospitals	53,508	32,961 (61.6)	7,713 (14.4)	8,387 (15.7)	3,414 (6.4)	1,032 (1.9)	214 (0.4)	2,765 (5.2)	7,664 (14.8)	8,848 (16.9)	13,484 (24.1)	21,037 (39.3)
Public Sector												
Metropolitan												
Mater Hospitals	17,711	16,722 (94.4)	751 (4.2)	167 (1.0)	40 (0.2)	29 (0.2)	553 (3.1)	197 (1.1)	2,198 (12.4)	454 (2.6)	164 (0.9)	14,698 (83)
Gold Coast	13,099	8,136 (61.1)	4,086 (31.2)	855 (6.6)	12 (0.1)	9 (0.1)	227 (1.7)	166 (1.2)	354 (2.7)	2,245 (17.3)	10,260 (79.3)	74 (0.6)
Metro North	24,173	19,961 (82.6)	3,643 (15.1)	399 (1.7)	133 (0.6)	37 (0.2)	1,016 (4.2)	641 (2.4)	404 (1.7)	14,625 (60.7)	534 (2.2)	7,969 (33.1)
Metro South	16,467	10,861 (66)	5,354 (32.5)	183 (1.1)	64 (0.4)	5 (0.03)	739 (4.5)	30 (0.1)	10,498 (63.8)	636 (3.9)	259 (1.6)	5,044 (30.7)
Sunshine Coast	8,490	3,691 (43.4)	3,388 (39.9)	1,328 (15.7)	62 (0.8)	24 (0.3)	331 (3.9)	1,459 (17.2)	34 (0.4)	50 (0.6)	6,910 (81.4)	37 (0.4)
Townsville	8,369	22 (0.1)	0 (0.0)	5,613 (67.1)	1,723 (20.6)	1,011 (12.1)	1,513 (18.0)	320 (3.8)	870 (10.4)	7 (0.1)	6,802 (81.3)	371 (4.4)

Regional												
Cairns and Hinterland	9,419	10 (0.1)	1 (0.01)	7,748 (79.6)	753 (84)	1,112 (11.9)	2,760 (29.3)	3,295 (33.6)	5,9398 (64)	3 (0.3)	14 (0.2)	168 (1.8)
Central QLD	7,163	11 (0.2)	183 (2.6)	2,631 (36.7)	4,168 (58.2)	170 (2.3)	781 (10.9)	154 (2.1)	3,629 (50.7)	338 (4.7)	1,835 (25.6)	1,207 (16.9)
Darling downs	9,253	27 (0.3)	4,764 (50.4)	3,485 (36.8)	999 (10.8)	166 (1.8)	1,049 (11.3)	2,420 (26.2)	2,078 (22.5)	4,729 (52.1)	10 (0.1)	16 (0.2)
Mackay	4,948	7 (0.1)	7 (0.1)	3,597 (72.7)	576 (11.7)	761 (15.4)	342 (6.9)	10 (0.2)	1,1,39 (23)	4 (0.1)	3,346 (67.7)	449 (9.1)
West Moreton	8,681	4,439 (51.1)	3,575 (41.2)	642 (7.4)	11 (0.1)	14 (0.2)	527 (6.1)	931 (10.7)	4,150 (47.8)	3,255 (38)	6 (0.1)	341 (3.9)
Wide Bay	6,360	12 (0.2)	2,056 (32.4)	4,176 (65.7)	107 (1.7)	9 (0.1)	459 (7.2)	6,164 (96.9)	55 (0.9)	7 (0.1)	111 (1.8)	23 (0.4)
Rural and remote												
Central West	294	2 (0.7)	0 (0.0)	2 (0.7)	6 (2.1)	284 (96.6)	25 (8.5)	65 (21.8)	10 (3.4)	215 (73.4)	1 (0.3)	3 (1.0)
North West	1,573	37 (1.3)	0 (0.0)	2 (0.1)	2 (0.1)	1,532 (99.4)	609 (38.7)	1,546 (98.3)	3 (0.2)	22 (1.4)	1 (0.1)	1 (0.1)
South West	811	8 (1)	3 (0.4)	0 (0.0)	204 (25.2)	596 (73.4)	155 (19.1)	77 (9.6)	188 (23.4)	554 (67.1)	2 (0.3)	0 (0.0)
Torres and Cape	409	9 (0.2)	0 (0.0)	(0.2)	18 (4.4)	381 (95.2)	345 (84.4)	401 (98)	1 (0.2)	0 (0.0)	0 (0.0)	7 (1.8)

There was a spread of caesarean section rates within each of the public sector regional clusters (Table 5.2). The Private sector had the overall highest percentage of caesarean sections and correspondingly lowest percentage of non-instrumental vaginal deliveries. Torres and the Cape had the lowest percentages of all obstetric interventions and the highest percentage of non-instrumental vaginal delivery.

Table 5.2: Percentage (%) of obstetric interventions[15] by Hospital and Health Service in Queensland, between 01 July 2012 and 30 June 2015.

Hospital and Health Service	***Caesarean section***	***Instrumental vaginal birth***	***Non-instrumental vaginal birth***	***Induction of labour***	***Episiotomy***	***Epidural analgesia***
Queensland	*63,703 (33.4)*	*20, 599 (10.8)*	*106,426 (55.8)*	*47,110 (24.7)*	*12,588 (6.6)*	*30,898 (16.2)*
Private sector						
Private hospitals	25,898 (48.4)	6,796 (12.7)	20,815 (38.9)	14,501 (27.1)	4,067 (7.6)	10,059 (18.8)
Public sector						
Metropolitan						
Metro North	7,907 (32.71)	2,683 (11.1)	13,585 (56.2)	5,270 (21.8)	1,813 (7.5)	4,520 (18.7)
Townsville	2,446 (29.23)	745 (8.9)	5,180 (61.9)	2,134 (25.5)	603 (7.2)	929 (11.1)
Metro South	4,792 (29.1)	1,383 (8.4)	10,292 (62.5)	3,969 (24.1)	840 (5.1)	2,651 (16.1)
Mater hospitals	5,002 (28.24)	2,621 (14.8)	10,095 (57.0)	4,888 (27.6)	1,736 (9.8)	3,170 (17.9)

[15] The outcomes were calculated as a proportion out of all births. Some modes of birth are exclusive of other modes, ie. Vaginal delivery and caesarean section. And some interventions are not exclusive. Therefore, some women receive multiple interventions and the percentage of interventions for each HHS will add up to be greater than 100%.

Sunshine Coast	2,123 (25.0)	942 (11.1)	5,425 (63.9)	1,791 (21.1)	357 (4.2)	1,605 (18.9)
Gold Coast	2,869 (21.9)	1,506 (11.5)	8,724 (66.6)	3,327 (25.4)	773 (5.9)	2,227 (17)
Regional						
Cairns and Hinterland	2,741 (29.1)	819 (8.7)	5,859 (62.2)	2,006 (21.3)	377 (4)	1,111 (11.8)
Wide Bay	1,774 (27.9)	566 (8.9)	4,020 (63.2)	1,463 (23)	331 (5.2)	757 (11.9)
Darling downs	2,517 (27.2)	666 (7.2)	6,070 (65.6)	1,897 (20.5)	435 (4.7)	1,249 (13.5)
Central QLD	1,827 (25.5)	451 (6.3)	4,892 (68.3)	1,461 (20.4)	387 (5.4)	645 (9)
Mackay	1,257 (25.4)	594 (12)	3,102 (62.7)	1,291 (26.1)	312 (6.3)	668 (13.5)
West Moreton	2,083 (24)	686 (7.9)	5,920 (68.2)	1,910 (22)	451 (5.2)	1,172 (13.5)
Rural and remote						
South West	241 (29.7)	65 (8.01)	505 (62.3)	136 (16.8)	32 (4)	34 (4.2)
North West	436 (27.7)	145 (9.2)	994 (63.2)	445 (28.3)	120 (7.6)	176 (11.2)
Central West	66 (22.5)	25 (8.5)	203 (69.1)	71 (24.2)	9 (3.0)	18 (6.1)
Torres and Cape	59 (14.4)	13 (3.2)	409 (82.4)	57 (14)	6 (1.5)	4 (1)

After adjusting for mothers' socioeconomic and clinical characteristics (Table 5.3), we found:

- Caesarean section was the highest at Private hospitals, South West, Townsville, Metro South, and Cairns (see Figure 5.2).
- The Gold Coast Hospital and Health Services and Torres and the Cape had the lowest percentage of caesarean sections (see Figure 5.2).
- Variation in the percentage point of caesarean section between Hospital and Health Services was 23.6 percentage points. Induction of labour was highest at North West, Mater Hospitals and Private hospitals.

- Variation in the percentage point of induction of labour between Hospital and Health Services was 13.4 percentage points. Instrumental vaginal delivery was highest at Mater Hospitals, Private hospitals and Mackay.
- Variation in the percentage point of instrumental vaginal delivery between Hospital and Health Services was 6.9 percentage points. Episiotomy was highest at the Mater Hospitals, Private Hospitals and North West.
- Variation in the percentage point of episiotomy between Hospital and Health Services was 6.5 percentage points. Epidural analgesia was highest at the Sunshine Coast, Private Hospitals and Metro North.
- Variation in the percentage point of epidural analgesia between Hospital and Health Services was 11.3 percentage points. Non-instrumental vaginal delivery was highest at Torres and the Cape and lowest in Private Hospitals and Metro North Hospital and Health Service.
- Variation in the percentage point of non-instrumental vaginal deliveries between Hospital and Health Services was 30.2 percentage points.

Table 5.3: Adjusted[16] *Percentage (%) of obstetric interventions by Hospital and Health Service in Queensland, between 01 July 2012 and 30 June 2015.*

Hospital and Health Service	***Caesarean section***	***Instrumental vaginal birth***	***Non-instrumental vaginal birth***	***Induction of labour***	***Episiotomy***	***Epidural analgesia***
Private sector						
Private hospitals	24,507 (45.8)	6,849 (12.8)	22,152 (41.4)	14,875 (27.8)	4,109 (7.68)	10,290 (19.23)
Public Sector						
Metropolitan						
Townsville	2,645 (31.6)	787 (9.4)	4,938 (59)	2,000 (23.9)	633 (7.56)	1,036 (12.38)

[16] Analysis *adjusted for a pre-existing health condition, maternal age, previous pregnancy complications, complications arising during the current pregnancy, area-based socioeconomic deprivation, Indigenous status, distance from the birthing facility, smoking and BMI at birth*

Mater Hospitals	5,296 (29.9)	2,320 (13.1)	10,095 (57)	5,136 (29)	1,528 (8.63)	2,775 (15.67)
Metro South	5,088 (30.9)	1,301 (7.9)	10,078 (61.2)	4,150 (25.2)	807 (4.90)	2,508 (15.23)
Sunshine Coast	4,594 (27.9)	1,712 (10.7)	10,111 (61.4)	3,771 (22.9)	639 (3.88)	3,086 (18.74)
Metro North	6,720 (27.8)	2,587 (10.7)	14,866 (61.5)	4,375 (18.1)	1,726 (7.14)	3,940 (16.30)
Gold Coast	3,091 (23.6)	1,402 (10.7)	8,606 (65.7)	3,497 (26.7)	697 (5.32)	2.092 (15.97)
Variation in % points	8	5.2	8.7	11	4.8	6.36
Regional						
Cairns and Hinterland	2,892 (30.7)	998 (10.6)	5,529 (58.7)	1,997 (21.2)	506 (5.37)	1,445 (15.34)
Central QLD	2,142 (29.9)	523 (7.3)	4,498 (62.8)	1,433 (20)	438 (6.12)	815 (11.38)
Wide Bay	1,895 (29.8)	661 (10.4)	3,803 (59.8)	1,545 (24.3)	410 (6.44)	954 (15)
Darling downs	2,619 (28.9)	749 (8.1)	5,829 (63)	1,841 (19.9)	500 (5.40)	1,383 (14.95)
Mackay	1,385 (28)	633 (12.8)	2,959 (59.8)	1,232 (24.9)	335 (6.77)	751 (15.18)
West Moreton	2,300 (26.5)	677 (7.8)	5,703 (65.7)	2,005 (23.1)	458 (5.28)	1,163 (13.40)
Variation in % points	4.2	5.5	7	5	1.5	4
Rural and remote						
South West	294 (36.2)	84 (10.3)	437 (53.9)	138 (16.97)	44 (5.47)	73 (8.98)
North West	459 (29.2)	200 (12.7)	915 (58.2)	411 (26.11)	158 (10.04)	275 (17.46)
Central West	83 (28.2)	34 (11.6)	178 (60.7)	75 (25.65)	14 (4.86)	35 (11.85)
Torres and Cape	91 (22.3)	25 (6.2)	293 (71.6)	64 (15.58)	17 (4.22)	33 (7.95)
Variation in % points	13.9	6.5	17.7	10.6	5.8	9.5

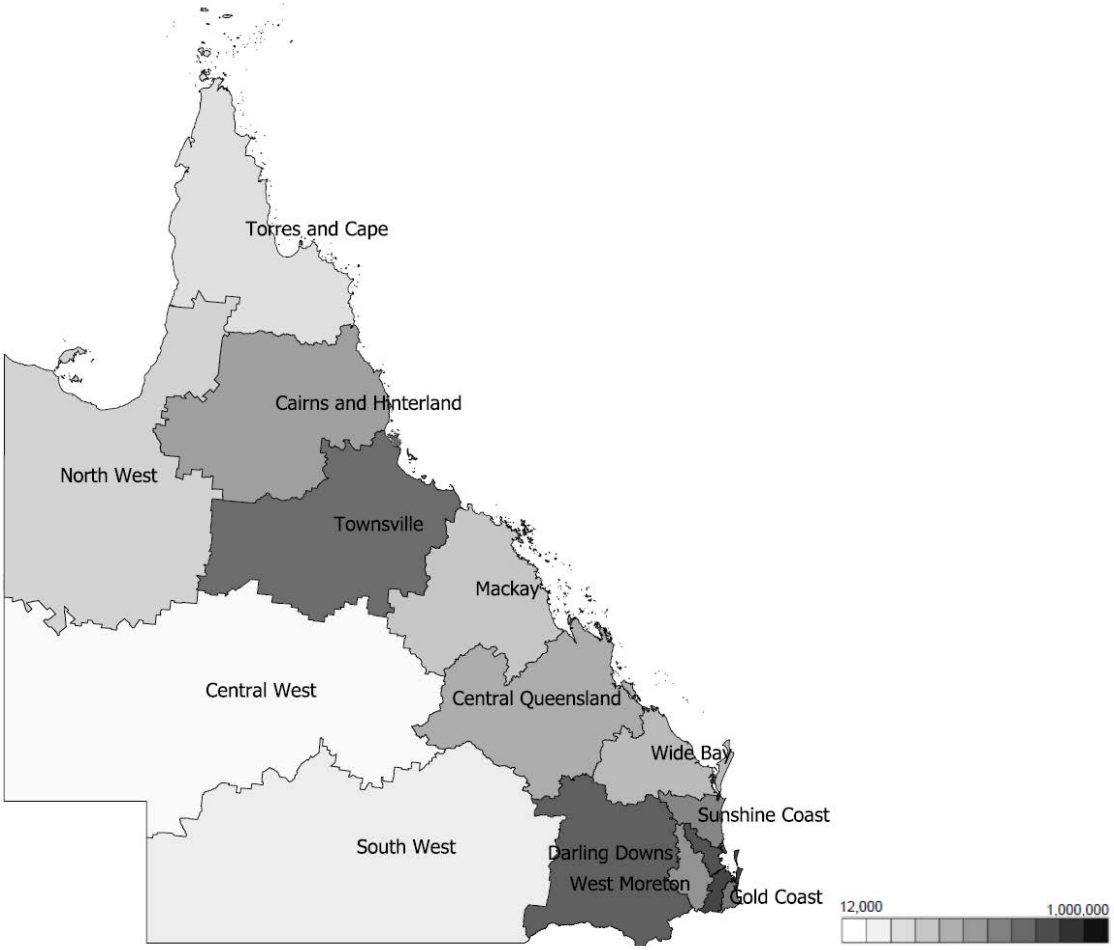

Figure 5.1: Population with Hospital and Health Service jurisdictions in Queensland.

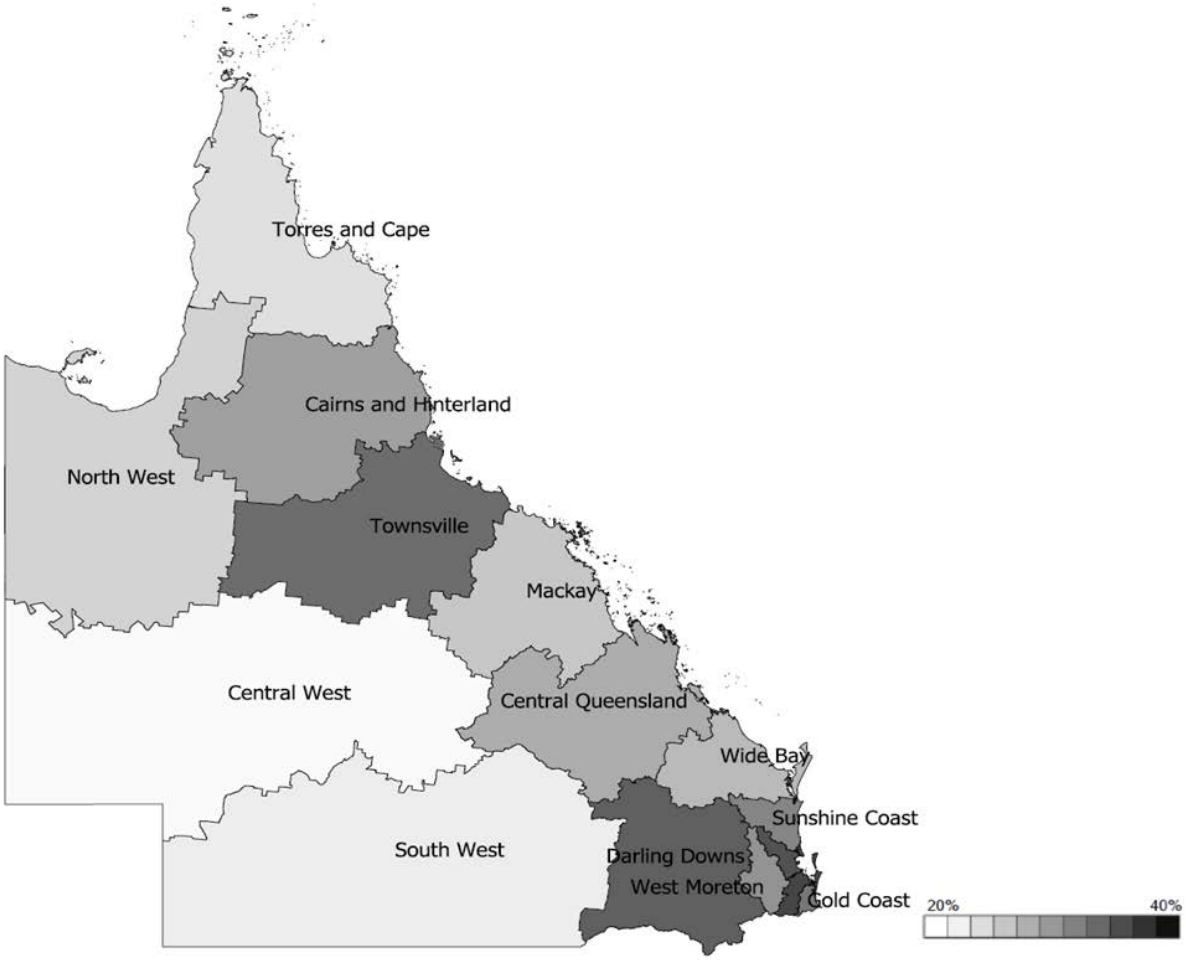

Figure 5.2: Caesarean section adjusted percentages by Hospital and Health Service Jurisdiction

Discussion

We report three key findings from the result of this study. First, that there are high rates of obstetric intervention, indicative of overuse, in both the private and public sectors. Second, and notwithstanding the general pattern of overuse, that there are much higher rates of intervention in the private sector as compared to the public sector. Finally, within the public sector, there is substantial variation in rates of intervention between Hospital and Health Services and that this variation does not appear to be associated with geographic location or the size of the health service.

This study builds upon previous studies and reports (49, 114) that compare the provision of obstetric interventions between states and territories, the public and private sector, population groups and by remoteness. There are several Australian studies that demonstrate variation in obstetric practice between population groups (113, 236, 237), geographical regions (49, 113, 114) and between the public and private sector (49, 132, 213). Further, Safer Care Victoria releases an annual report,

'*Perinatal Services Performance Indicators'*, which seeks to promote transparency and shared accountability for performance improvement (49). Similar to our study, Safer Care Victoria reports a wide variation in the use of obstetric interventions between hospitals in that state, with higher rates experienced among the private sector. High rates of induction of labour and caesarean section are also reported in various public hospitals across the state among *primipara* women with no clinical indication (50).Our study is one of few studies globally that has been able to draw on such a well-integrated dataset that allows for a micro-level analysis of obstetric intervention provision within a whole population.

Our results show high rates of obstetric intervention in both the public and private sector, indicative of overuse. Based on the World Health Organizations' suggested rate of 10% within a population, approximately 23% (14,906) of all caesarean sections that were performed in Queensland between 2012 and 2015 may be considered excessive. A caesarean section rate greater than 10% within a population has been shown to not lower maternal or neonatal mortality (1, 4-6). Rather, there is evidence that demonstrates increased intervention rates are associated with higher maternal and neonatal morbidity and mortality (57). Therefore, the World Health Organization states that caesarean section rates greater than this amount in a population may result in more harm than good and are likely to be medically unjustified and should be considered unnecessary (3). The use of this surgical procedure when it is not clinically indicated could result in avoidable negative health outcomes for mothers and babies and contribute to no discernible health benefits within a population. No internationally recognised measure of an appropriate population rate for episiotomy and induction exists, therefore, it is more difficult to interpret results regarding those interventions. However, since both of these interventions have seen consonant increases to caesarean section in Australia in the past twenty years (49, 52, 114), it seems reasonable to raise the possibility of similar patterns of overuse.

Notwithstanding the general pattern of overuse, a second key finding is there were much higher rates of intervention in the private sector as compared to the public sector, even after adjusting for factors known to increase the need for intervention. Private hospitals performed a greater amount of all obstetric interventions and had a lower percentage of non-instrumental vaginal deliveries, which is consistent with previous findings within peer-reviewed literature (132, 213) and national Government reports (114). This could be due to factors such as women not having access to midwifery care in the private sector, with Midwifery Group Practice caseload care being associated with lower rates of intervention and higher rates of non-instrumental vaginal deliveries (238, 239). Additionally, the private sector, which operates on a for-profit basis, may be more susceptible to the fee for service funding models within Australia (240), whereby the hospital and individual provider

are financially rewarded for every occasion of care that is provided, which can incentivise volume of care and deliver high-cost types of care (241).

High obstetric intervention rates in Australia are commonly attributed by health professionals to the changing epidemiology of women giving birth such as increasing age and maternal obesity (242-245). Factors such as age and obesity are not direct indications for caesarean section, rather they increase the likelihood of pregnancy risk factors such as pre-eclampsia and gestational diabetes, and therefore place women in a 'high-risk' pregnancy category, predisposing them to caesarean delivery (246). Australia has seen an increase in mean maternal age and the average Body Mass Index of birthing women (52, 113), which has coincided with an increase in caesarean delivery. And although the characteristics of birthing women are changing in Australia, caesarean sections (and other obstetric interventions) are rising among all population groups regardless of risk factors (49, 113, 247). Non-Indigenous, wealthy, urban mothers who are less likely to have maternal risk factors currently experience the highest rates of obstetric interventions (236).

A third clear finding from this study is that rates of obstetric intervention vary substantially between public sector Hospital and Health Services and that this variation is not wholly attributable to clinical or demographic factors. Furthermore, our study was confirmatory of variation in obstetric practice between the public and private sector, but when examined at the micro-level we did not find geographical variation as we do in other studies. It was not unexpected that our unadjusted figures demonstrated that some Hospital and Health Services had higher rates of intervention than others. This could be due to factors such as some hospitals (e.g., Cairns Hospital and the Royal Brisbane and Women's hospital), receiving transfers of pregnant women who are classified as a moderate to high-risk pregnancy from hospitals outside of their Hospital and Health Service jurisdiction. Due to the closure of more than 130 rural maternity units across Australia between 1991 and 2006 (248), alongside the closure of one-third of hospitals, with the greatest reduction experienced in communities that saw between 1-100 births per year (175, 249), rural and remote communities such as those in Torres and the Cape do not have the appropriate facilities to care for complex pregnancies and women birthing within this jurisdiction could be required to travel over a thousand kilometres to attend a hospital with more specialised capabilities (250). Therefore, these women go to Cairns hospital at 36 weeks gestation as they are able to provide care for women who experience complex pregnancies (251). These circumstances may also partially explain the lower rates of interventions within Torres and the Cape Hospital and Health Service. Similarly, metropolitan hospitals such as the Royal Brisbane and Women's hospital, which are well-resourced in terms of specialists and technical equipment, also receive clinically complex pregnancies.

However, our results adjusted for demographic, health and clinical factors that could warrant the need for a caesarean section, and after adjustment, our results still demonstrated high rates of obstetric interventions across all Queensland Hospital and Health Services, as well as a variation of 24% between the Hospital and Health Services that provided the highest and lowest number of caesarean sections. The sizeable variation after adjusting for mothers' clinical and demographic characteristics indicates a potential variation in clinical practice between Hospital and Health Services. There is no obvious pattern in relation to rurality, which might have been expected due to previous reports (49, 113, 114). The two Hospital and Health Services that demonstrate lower patterns of obstetric interventions include a metro Hospital and Health Service (Gold Coast) and a rural and remote Hospital and Health Service (Torres and the Cape) The Rural Maternity Task Force has demonstrated that there are increasing rates of maternity risk factors and lower attendance at antenatal appointments associated with increasing distance from services (252). Although there is a higher prevalence of risk factors such as smoking, obesity and pre-existing medical conditions in a Hospital and Health Service jurisdictions such as Torres and The Cape, there is also limited physical access to higher capability services (252). Yet, the Gold Coast, with a much smaller geographical region requiring shorter travel distances for high capability maternity services, still experiences lower rates of interventions. These findings imply it is not solely the distance to travel, or distance needed to travel when a referral is needed, that influences the rates of obstetric interventions.

The combination of excessive obstetric interventions in the private sector in combination with the variation in percentages between public sector Hospital and Health Services suggests that service planning and delivery at or below the level of Hospital and Health Service are at least partially influencing the number of obstetric interventions provided. Recent evidence has demonstrated that supply-side factors at the hospital and doctor level could be driving variation in intervention rates when women are cared for either in the private sector or by a privately practising doctor (either in a public or private hospital) in Australia (253). Some variation in clinical practice is both warranted and expected due to reasons such as differences in population health status, different cultural expectations or the patient's personal expectations. Whilst many caesarean sections may be warranted at the time the caesarean section is performed, increased access to Midwifery Group Practice caseload care could help to avoid the need for caesarean section arising. In addition to clinical factors that are known to increase the rate of caesarean section, health system and organisational factors can be important determinants of caesarean section use, potentially driving the variation seen in this study (29). Health provider birth philosophy has been recognised as having influence over the significance that health providers have towards caesarean section reduction (254). Further exploration is required to understand whether the variation in obstetric care is

warranted or whether the variation is an indication of issues within the system or health service organisation.

The excessive provision of obstetric interventions in Queensland is of concern due to both the potential negative short and long-term health consequences that can be experienced by mothers and babies and also the poor use of finite maternal healthcare resources. Caesarean sections cost on average 26% more to the health system over the first 1,000 days of the perinatal journey compared to non-instrumental vaginal delivery (233). The unwarranted use of healthcare resources could result in some mothers and babies missing out on clinically necessary care. This is of particular importance for socioeconomically, geographically and ethnically marginalised population groups who are more likely to have greater maternal health care needs. When examined at the population level, a higher number of obstetric interventions are being provided to wealthier, non-indigenous, urban women, who typically have fewer maternal healthcare needs (49, 114, 236). The excess provision of caesarean sections to these population groups could mean that essential resources are diverted away from marginalised population groups with greater healthcare needs in order to pay for medically unnecessary surgical procedures. Therefore, the overuse of caesarean sections can influence equity in the availability of maternal health services within a population.

A major strength of this study is the results are based upon a whole of population linked administrative dataset whereby the data is routinely collected, limiting the potential for bias. Another strength of the study is the individual level of the dataset. This allowed for micro-level analysis as opposed to relying upon averages to produce results for individual maternal healthcare services. A potential limitation of this study is the inability to account for all of the individual needs and preferences of mothers in our analysis. However, there is an almost growing international consensus that such high rates of caesarean section are not being driven by clinical necessity (11, 32, 135, 255). A final limitation is that the measure of socioeconomic disadvantage is area-based and not measured at the individual level.

Conclusion

This study demonstrates that after adjusting for socioeconomic and clinical factors that can influence the need for medical intervention during labour and birth, rates of obstetric intervention in Queensland between 2012 and 2015 were excessive in both the private and public sector, with particularly high rates in the private sector, alongside considerable variation in intervention rates between public sector health service jurisdictions. A deeper understanding of what factors might be driving high rates of caesarean section at the health service level, with a focus on the clinical necessity of caesarean section provision is required.

Summary of Section 2

Section 2 addressed research question 1 of the thesis: *Does variation in maternal health care and service provision exist between subpopulation groups and hospital and health service jurisdictions in Queensland, Australia?* The main outcomes of interest included obstetric interventions (caesarean section, induction of labour, instrumental vaginal birth, episiotomy, and epidural) and primary care services (antenatal care, mental health, and chronic disease care).

In summary, the results from section 2 of the thesis demonstrated evidence of overuse of obstetric interventions in the Queensland population and that variation exists in obstetric practice that is not solely attributable to the clinical needs of mothers. After adjusting for key clinical characteristics that might increase the likelihood of receiving an obstetric intervention, there was a general trend of non-urban, First Nations, and socioeconomically disadvantaged mothers being more likely to have a non-instrumental vaginal birth and less likely to receive obstetric interventions, including caesarean section, compared to their urban, non-First Nations and socioeconomically advantaged counterparts. Substantial variation in obstetric interventions also exists between Hospital and Health Services, whereby the variation does not appear to be solely associated with the clinical risk factors of the women within the health service jurisdiction or the size or capability of the individual health service.

These findings indicate that potentially, there are non-clinical factors that may be contributing to the variation in care between groups of women and between Hospital and Health Services. Non-clinical factors that can influence variation in care could be associated with women themselves such as fear of birth; with health providers such as individual preferences; with individual health services such as policies and procedures or hospital culture; factors at the health system level such as financing policies, or a combination of some or all of these factors. The evidence of overuse presented in Section 2 of the thesis may be a reflection of a culture of risk aversion, which dominates medical discourse and practices related to childbirth in some highly industrialised countries such as Australia (256, 257), whereby even low-risk pregnancies and births are carefully monitored with technological surveillance such as electronic fetal monitoring (258).

The results of section 2 also demonstrate that there are disparities in health service coverage for women during the perinatal period, which disproportionately affect rural and remote, First Nations and socioeconomically disadvantaged mothers who experience hypertension, diabetes and mental health conditions during the perinatal period. Although First Nations, socioeconomically disadvantaged and rural and remote mothers experience a greater burden of perinatal risk factors, these groups of mothers have reduced health service coverage, specifically antenatal care and

mental health services. One exception to this general finding was that First Nations mothers with either diabetes or hypertension had greater health service use for chronic disease management than their non-First Nations counterparts. The findings in section 2 indicates that both primary and tertiary healthcare resources favour non-First Nations mothers, mothers living in cities and those who experience the least socioeconomic disadvantage within the study population. Evidence of inequitable resource allocation exists in Australian literature with socioeconomically disadvantaged (259), rural and remote (175) and First Nations peoples (260) being disproportionately affected. Political will; commitment at the state government and hospital and health service level towards the maternal health care reform agenda of ensuring that Australian maternity services are equitable, alongside a reduced complacency that Medicare is fair is required if Australia's maternal health system is to meet the needs of all women.

Future research should consider the birth preferences of mothers and also gaining a better understanding of the interactions between women and their maternal health providers. Policymakers should consider the distribution of maternal health care resources, to ensure that those who need them most, are receiving them. The findings in this section should be considered in the context of the limitation of the measurement of socioeconomic disadvantage, which was area-based and not measured at the individual level.

This concludes section 2 and leads into Section 3 of the thesis, which will be a case study focusing on the health provider reasons for providing primary caesarean sections in the Queensland public and private health sectors, in order to better understand the potential clinical drivers and clinician reasons for providing caesarean sections that are driving the observed trend of above optimal use of obstetric interventions and variation in obstetric care.

Section 3: A case study of the clinical drivers and health provider reasons for caesarean section provision in public and private hospitals.

This section of the thesis addresses research question number 2: *What are the clinical drivers and health provider reasons for providing caesarean sections in Queensland public and private hospitals?* Section 3 contains one published paper and one that is under review. Two supplementary articles are also in this section including a Letter to the Editor (under review) that was received in response to the article in Chapter 6, alongside a response to the Letter to the Editor (under review). In chapter 6 and chapter 7 the clinical drivers and health provider reasons for providing caesarean sections in Queensland public and private hospitals are respectively, examined.

The publications included in this section of the thesis include:

- **Fox, H**., Topp, S., Lindsay, D., Callander, E. A cascade of interventions: A classification tree analysis of the determinants of primary caesarean sections in Australian public hospitals**.** *Birth.* 2021. DOI: 10.1111/birt.12530
- **Fox, H**., Topp, S., Lindsay, D., Callander, E. Determinants of caesarean sections in Australian private hospitals. *Midwifery*. Under review. 2021.

Supplementary files:

- Unknown author. The “Cascade of interventions”. Does it really exist? *Birth*. Under review. 2021.
- **Fox, H**., Topp, S., Lindsay, D., Callander, E. Response to: The “Cascade of interventions”. Does it really exist?. *Birth*. Under review. 2021.

Section 1: Introduction and methods

Chapter one: Introduction

Chapter two: Methods

Section 2: Inequities in maternal health service provision

Chapter three: Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers

Fox H, Callander E, Lindsay D, Topp S. Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers. *BMC Pregnancy and Childbirth*. 2019;19(1):226. DOI: https://doi.org/10.1186/s12884-019-2369-5

Chapter four: Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia.

Fox H, Topp S, Lindsay D, Callander E. Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia. *International Journal of Health Planning and management*. 2021; DOI: https://doi.org/10.1002/hpm.3277

Chapter five: Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals.

Fox H, Callander E, Lindsay D, Topp S. Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals. *Australian Health Review*.2021; DOI: https://doi.org/10.1071/AH20014

Research question 1

Section 3: A case study of the determinants of caesarean section provision in Queensland hospitals.

Chapter six: A cascade of interventions: determinants of caesarean sections in Australian public hospitals.

Fox H, Topp S, Lindsay D, Callander E. A cascade of interventions: determinants of caesarean sections in Australian public hospitals. *Birth.* 2021. DOI: https://doi.org/10.1111/birt.12530

Chapter seven: Drivers of primary caesarean sections in Australian private hospitals..

Fox H, Topp S, Lindsay D, Callander E. Determinants of caesarean sections in Australian private hospitals. *Midwifery*. Under review. 2021.

Research question 2

Section 4: Macro-level healthcare financing policy levers of maternal health care

Chapter eight: A review of the impact of financing mechanisms on maternal health care in Australia

Fox H, Topp SM, Callander E, Lindsay D. A review of the impact of financing mechanisms on maternal health care in Australia. BMC public health. 2019;19(1):1540. DOI: https://doi.org/10.1186/s12889-019-7850-6

Research question 3

Section 5: Discussion and conclusion

Chapter nine: Discussion and conclusion

CHAPTER 6: A cascade of interventions: determinants of caesarean sections in Australian public hospitals

Abstract

Background:

Both globally and in Australia, there has been a sharp rise in Caesarean Births (CB). Commonly, this rise has been attributed to the changing epidemiology of women giving birth. A significant body of knowledge exists on the risk factors associated with a greater need for caesarean. Yet, we have little information on the reasons recorded by clinicians as to why caesareans are provided. This study aimed to explore the drivers of primary caesareans in Australian public hospitals.

Methods:

Utilising a linked administrative dataset, the frequency and percent of mothers' characteristics were compared between those who had a caesarean birth and those who had a vaginal birth (n=98,967) with no history of previous caesareans in Queensland public hospitals between 1 July 2012 and 30 June 2015. The top 10 reasons recorded by clinicians for a primary caesarean were reported. Using a machine-learning algorithm, two decision trees were built to determine factors driving primary caesarean birth.

Results:

'Labour and delivery complicated by fetal heart rate anomaly' (23%) and 'primary inadequate contractions' (22.8%) were the top two reasons for a primary caesarean birth. The most common characteristics among mothers who had fetal heart rate anomalies were: artificial rupture of membranes (39%), oxytocin (32%); no obstruction of labour (42%) and epidural (52%). For women who had primary inadequate contractions, the most common characteristics were: epidural (33%); oxytocin (49%); artificial rupture of membranes (45%) and fetal stress (56%).

Conclusion:

Efforts should be made by health providers during the antenatal period to maximize the use of preventative measures that minimize the need for medical interventions.

Introduction

Caesarean rates have risen around the world in the past 20 years causing global concern among researchers, health practitioners and consumers (28). In the recent Lancet series, *'Optimising caesarean section use'*, it was stated that often the decision to perform a caesarean is driven by the clinical or psychological needs of the mother and or baby (55). Commonly, increasing rates of caesarean birth (CB) are also attributed to the changing risk profiles of women giving birth such as increasing maternal age and obesity (56-58). Yet factors such as age and obesity are not direct indicators for the need to perform a caesarean. Rather, they can increase the likelihood of pregnancy risk factors such as pre-eclampsia, gestational diabetes, (246) infertility, (261) chromosome anomalies (262) and multiple pregnancies. However, an association between caesarean and increasing maternal age has been shown to exist independent of these risk factors (263). Advanced maternal age, which has been commonly defined as women over the age of 35, can automatically place women in a 'high-risk' pregnancy category, predisposing them to caesarean. The World Health Organization (WHO) states that maternal characteristics such as age and obesity alone are unlikely to explain the large increase in caesarean birth and the wide variation between settings (28, 30, 224).

Similar to the global trend, Australia has seen caesarean rates rise from 25% in 2000 (114) to 35% in 2017 (51). The rate of CB differs between the public and private sectors, with 26% of women giving birth via caesarean in public hospitals, and 32% of women giving birth via caesarean in private hospitals (49). In Australia, the increasing rate of CB is also attributed to the changing epidemiology of women giving birth such as increasing the average age of first child, increasing Body Mass Index (BMI) and the increasing use of assisted conception methods (242-245). Simultaneous to the increasing caesarean rate, there has been an increase in the mean maternal age and the average BMI of women giving birth (113, 264), but the contribution of older maternal age to the risk of morbidity and mortality is minimal (265). And, although the characteristics of women giving birth are changing in Australia, caesareans are rising among all population groups regardless of age or clinical characteristics (49, 51, 132). Non-Indigenous, wealthy, urban mothers who have lower rates of maternal risk factors such as diabetes and hypertension currently experience the highest rates of obstetric interventions (236).

A significant body of knowledge exists on the risk factors associated with a greater need for CB. Yet, we have little information on the reasons recorded by clinicians as to why caesareans are provided. Australia has recently started routinely collecting data on reasons for caesarean, which is documented by the clinician attending the birth (47). The Australian Institute of Health and Welfare (AIHW) reports that the most common reason for CB in Australia is a history of a previous caesarean,

with 86% of mothers who had a previous CB having a repeat caesarean in a subsequent birth (51). Therefore, a greater understanding of the decision to provide a *primary* caesarean is required to understand what is driving the high rates of CBs in Australian hospitals.

Given the global concern over increasing caesarean rates and associated negative health outcomes, an examination of the factors contributing to the provision of CB is essential to help ensure that this intervention is used only when clinically necessary. Using population-level data, the purpose of this study was to compare the demographic and clinical characteristics of women who had a primary caesarean with those who had a vaginal birth and to examine the main reasons for primary caesarean provision in Queensland public hospitals.

Methods

Data

This project utilised a linked administrative dataset that contains the records of mothers who gave birth between 1 July 2012 and 30 June 2015 (n=186,789), as well as their resultant babies (n= 189,909) from all 95 hospitals across Queensland. This study forms part of a larger maternal and child health data linkage project (99), which broadly aims to examine health service use and costs associated with childbearing and early childhood in Queensland, Australia.

All individuals were identified from the Queensland Perinatal Data Collection (PDC) and Queensland Birth Registry by Queensland Health's Statistical Services Branch (SSB). The records were then linked to Queensland Hospital Admitted Patient Data Collection (QHAPDC), Deaths Registry, Emergency Department Information System (EDIS) and Hospital and Health Service (HHS) Funding and Costing Unit records. The records were then linked by the Australian Institute of Health and Welfare (AIHW) to Medicare Benefits Schedule (MBS) and Pharmaceutical Benefits Scheme (PBS) claims records (28). For this study, we utilized inpatient hospital data including QHAPDC and the Queensland PDC datasets and MBS data. The population was limited to all mothers who gave birth in public hospitals.

ICD-10-AM

The ICD-10-AM 8th Edition was used in this study to categorise health conditions, procedures and reasons for caesarean as reported by the clinician. The 8th addition was used to reflect the dates of the data used in this study (182). ICD-10-AM is the International Statistical Classification of Diseases and Related Health Problems, Australian Modification (266).

Maternal characteristics

Body Mass Index (BMI) categories were based on the WHO classifications(267). We categorised mothers' socioeconomic status using the Index of Relative Socioeconomic Disadvantage (IRSD),

which is based on mothers' postcode of residence at the time of birth (118). We used the IRSD to rank the study population into five ordinal categories (IRSD 1-5), with IRSD1 representing mothers living in areas of greatest socioeconomic disadvantage and IRSD5 representing mothers living in areas of the least socioeconomic disadvantage. Mothers who identified at antenatal visits as either Aboriginal and/or Torres Strait Islander were recorded on the Queensland Perinatal Data Collection. In this paper, those mothers who responded 'yes' as either Aboriginal and/or Torres Strait Islander will be referred to as 'First Nations' and those who identified as not being either Aboriginal and/or Torres Strait Islander will be referred to as 'non-First Nations'. We used the Australian Bureau of Statistics (ABS) Accessibility/Remoteness Index of Australia (ARIA+) to categorise mothers' rurality based on their postcode of residence at the time of birth (119).

Assisted conception is recorded on the QPDC as either a pregnancy that was achieved by Artificial Insemination; Ovulation Induction; In Vitro Fertilisation; Gamete Intrafallopian Transfer; Intracytoplasmic Sperm Injection; Donor Egg; or Embryo Transfer. If mothers on the Maternity1000 dataset had an ICD-10-AM code that included either pre-existing diabetes mellitus or diabetes mellitus in pregnancy they were classified as 'diabetes during pregnancy'. If mothers on the Maternity1000 dataset had an ICD-10-AM code that included either gestational hypertension; chronic hypertension; pre-eclampsia; eclampsia; and preeclampsia superimposed on chronic hypertension they were classified as 'Hypertensive Disorders of Pregnancy'.

Statistical analysis

The analysis was limited to all women who had not previously had a caesarean birth. The frequency and percent of mothers who gave birth via caesarean and vaginal birth in Queensland public hospitals between 1 July 2012 and 30 June 2015 were reported by demographic and clinical characteristics, and the association between characteristics and birth delivery type were compared with chi-square analyses. The frequency and percentage of the top 10 reasons recorded by clinicians for a primary CB as per the ICD-10-AM codes were also reported. Only one reason can be reported per woman, therefore, these groups are exclusive of one another.

To predict which mothers were likely to experience the top two reported reasons for primary CB, two decision trees were built using the HPSPLIT procedure (268). The decision tree uses a machine-learning algorithm to identify mutually exclusive and exhaustive subgroups of a population whose members share common characteristics that influence the dependent variable of interest (269). In this model, a 'classification' tree was utilized as the model contained only categorical responses. An extensive list of maternal health and clinical characteristics were included in the model (Appendix 3) as independent (predictor) variables, whilst 'fetal heart rate anomaly' and 'primary inadequate

contractions' were the dependent variables (as they were the top two reasons for primary CB). Observations for which the response variables were missing were omitted from the analysis. A variable of importance procedure was performed as part of the classification tree analysis, which selects the most useful independent variables for predicting the dependent variable, as important variables may not be near the top of the classification tree (268). For further details on the HPSPLIT procedure, please refer to the 'SAS/STAT® 14.1 User's Guide' (p 4,576-4,659)(268) and Appendix 4 of this manuscript. Each individual node within the classification tree adds up to 100% of either 'yes' or 'no' for the dependent variable. In our results, we present only the percentage of 'yes' as having the dependent variable; we do not present the percentage that was 'no' and did not have the dependent variable. The ordering of the nodes in the classification tree is determined by the level of probability that the independent variable will cause the outcome of interest to occur, with the highest probability at the top descending to the lowest probability at the bottom of the tree.

All analysis was undertaken using SAS9.4 statistical software.

Results

Between July 2012 and June 2015, 98,967 mothers who gave birth had no history of a previous caesarean. Of those, 17% (16,807) experienced a primary caesarean, and 83% had a vaginal birth.

A larger percentage of mothers who had a primary CB were aged over 35 years (26.8%) compared to mothers who had a vaginal birth (18.6%) (Table 6.1). However, the majority of mothers in both groups were aged between 25-34 years. The rate of twin pregnancy was higher among mothers who had a primary CB (10.8%) compared to mothers who had a vaginal delivery (1.5%) and the rate of breech presentation was higher for mothers who had a primary caesarean (19.5%) compared to mothers who had a vaginal birth (1%). The majority of women who had a primary caesarean were aged 25 – 34 (56%), had a BMI between 18.5 and 24.0 (71.5%), did not have assisted conception (95.5%), were not smokers (80.7%), did not have diabetes (85.5%) or hypertensive disorders (95.5%) in their pregnancy, their babies did not have congenital malformations (90.8%), and they had a singleton pregnancy (88.7%) with a vertex presentation (73.2%).

Table 6.1. Characteristics of women who had a primary caesarean section compared to women who had a vaginal delivery and no previous caesarean section.

Characteristics	**Primary caesarean section n (%)**	**No previous caesarean section and vaginal delivery n (%)**	**P Value**
Total 98,967	16,807 (17)	82,160 (83)	

Age			<.0001
<20	214 (2)	1,560 (2.4)	
20-24	1,680 (15.3)	12,555 (19.1)	
25-29	2,914 (26.5)	20,105 (30.7)	
30-34	3,233 (29.5)	19,158 (29.2)	
35-40	2,175 (19.7)	9,651 (14.7)	
40+	780 (7.1)	2,571 (3.9)	
BMI			<.0001
<18.00	682 (6.6)	4,969 (7.9)	
18.5–24.9	4,718 (45.5)	31,945 (50.5)	
25.0–29.9	2,700 (26)	14,961 (23.7)	
30.0–34.9	1,506 (14.5)	7,920 (12.5)	
35.0–39.9	775 (7.5)	3,472 (5.5)	
SEIFA			<.0001
Most disadvantaged	1,319 (12.1)	8,337 (12.8)	
2	2,627 (24.1)	15,654 (24)	
3	2,165 (19.8)	13,265 (20.3)	
4	2,230 (20.4)	14,876 (22.8)	
Least disadvantaged	2,571 (23.6)	13,102 (20.1)	
Indigenous status			<.0001
Yes	810 (7.4)	5,932 (9)	
No	10,165 (92.6)	59,665 (91)	
Rurality			<.0001
Urban	5,142 (47.1)	44.8 (38.4)	
Inner regional	2,175 (19.9)	13,927 (21.4)	
Outer regional	2,479 (22.7)	14,756 (22.6)	
Remote	686 (6.3)	4,318 (6.6)	
Very remote	430 (3.9)	3,003 (4.6)	
Assisted conception			<.0001
Yes	494 (4.5)	949 (1.5)	
No	10,484 (95.5)	64,651 (98.5)	
Tobacco smoking during pregnancy			.0001

Yes	2,108 (19.3)	13,751 (21.1)	
No	8,791 (80.7)	51,411 (78.9)	
Diabetes in pregnancy			<.0001
Yes	2,052 (14.5)	9,338 (11.4)	
No	12,107 (85.5)	72,928 (88.6)	
Hypertensive Disorders During Pregnancy			<.0001
Yes	640 (4.5)	2,403 (2.9)	
No	13,519 (95.5)	79,863 (97.1)	
Congenital malformations			<.0001
Yes	1,015 (9.2)	4,825 (7.4)	
No	9,963 (90.8)	60,775 (92.6)	
Plurality			<.0001
Singleton	9,732 (88.7)	64,631 (98.5)	
Twins	1,183 (10.8)	948 (1.5)	
Triplets or more	63 (0.6)	21 (0.03)	
Presentation			<.0001
Vertex	12,302 (73.2)	78,247 (95.3)	
Breech	3,277 (19.5)	821 (1)	
Other	1,210 (7.2)	3,037 (3.7)	

Almost half of all primary CBs were due to 'labour and delivery complicated by fetal heart rate anomaly' (23%) and 'primary inadequate contractions' (22.8%) (see Appendix 5 for full ICD-10-AM classifications (266)) (Table 6.2).

Table 6.2. Top 10 reasons for primary caesarean section in public hospitals in QLD.

Category title (ICD-10 code)	**N (%)**
Labour and delivery complicated by fetal heart rate anomaly (O68)	3,288 (22.97)
Primary inadequate contractions (O62)	3,259 (22.77)
Maternal care for unstable lie (O32)	1,833 (12.81)
No classifiable (medical, labour or delivery-related) condition (O82)	699 (4.88)
Supervision of high-risk pregnancy (Z35)	680 (4.75)
Twin pregnancy (O30)	607 (4.24)

Maternal care for rhesus isoimmunisation (O36)	529 (3.7)
Placenta praevia specified as without haemorrhage (O44)	451 (3.15)
Failed medical induction of labour (O61)	336 (2.35)
Mild to moderate pre-eclampsia (O14)	(1.58) 226

In the analysis, two classification trees were built to examine what factors were contributing to these top two clinical conditions—'fetal heart rate anomaly' and 'primary inadequate contractions'—driving primary caesarean provision in Queensland public hospitals.

Amongst the sample of mothers who had a primary caesarean, 41% experienced fetal heart rate anomaly (Figure 6.1). Within this sub-sample, abnormal fetal heart rate was present in 39% of mothers who had their membranes artificially ruptured compared to 20% of mothers who did not have their membranes artificially ruptured. In the mothers who had an obstructed labour, 18% experienced an abnormal fetal heart rate compared to 42% who did not have an obstructed labour. Among mothers who had oxytocin for induction or augmentation of labour, 32% experienced an abnormal fetal heart rate compared to 17% in mothers who did not have oxytocin. Among mothers who did have an epidural, 52% experienced an abnormal fetal heart rate compared to 38% in mothers who did not have an epidural. For mothers who had a primary CB in Queensland public hospitals, an abnormal fetal heart rate was most probable among those who had their membranes artificially ruptured, received oxytocin, did not have an obstructed labour and had an epidural. Artificial rupture of membranes (AROM), oxytocin, non-obstructed labour, and epidural were also,

respectively, in the top four variables of importance analysis for mothers who had an abnormal fetal heart rate (Table 6.3).

Please refer to Appendix 3 for further analysis on the correlation between 'fetal heart rate anomaly' and intrapartum interventions.

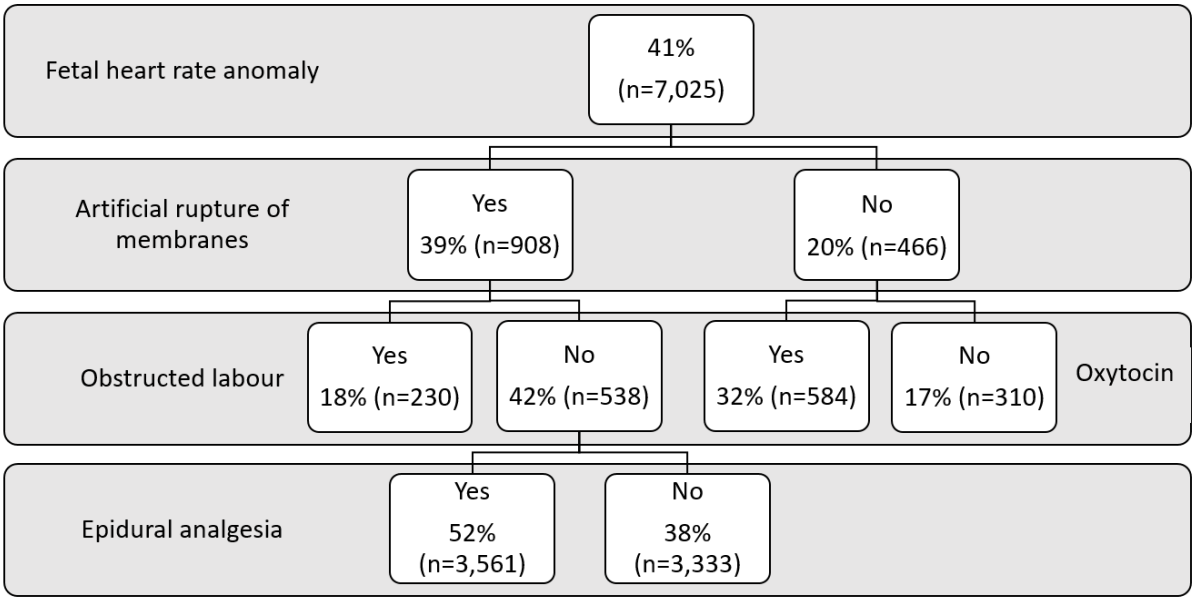

Figure 6.1: Prevalence (percentages) of fetal heart rate anomaly in mothers among classification tree subgroups

Table 6.3. Variables of importance for labour and delivery complicated by fetal heart rate anomaly

Importance	**Variable**
1	Artificial rupture of membranes
2	Oxytocin augmentation or induction of labour
3	Obstructed labour
4	Epidural analgesia
5	Socioeconomic status

After fetal heart rate anomaly, the next most commonly reported reason for primary caesarean was 'primary inadequate contractions'. (Figure 6.2). Within this sub-sample, primary inadequate contractions were present among 33% of mothers who had an epidural compared to 10% of

mothers who did not have an epidural. Among mothers who had oxytocin, 49% had primary inadequate contractions compared to 27% of mothers who did not receive oxytocin. Among mothers who had (AROM), 45% experienced primary inadequate contractions compared to mothers who did not have AROM. Among mothers who had fetal stress, 56% had primary inadequate contractions compared to 20% in mothers who did not have fetal stress. For mothers who had a primary caesarean in Queensland public hospitals, 'primary inadequate contractions' was the most common reason for CB given among those who had an epidural, received oxytocin, had AROM and experienced fetal stress. Epidural, AROM, fetal stress, oxytocin, and obstructed labour were also respectively in the top five variables of importance analysis for mothers who had primary inadequate contractions (Table 6.4). Please refer to Appendix 6 for further analysis on the correlation between 'primary inadequate contractions' and intrapartum interventions.

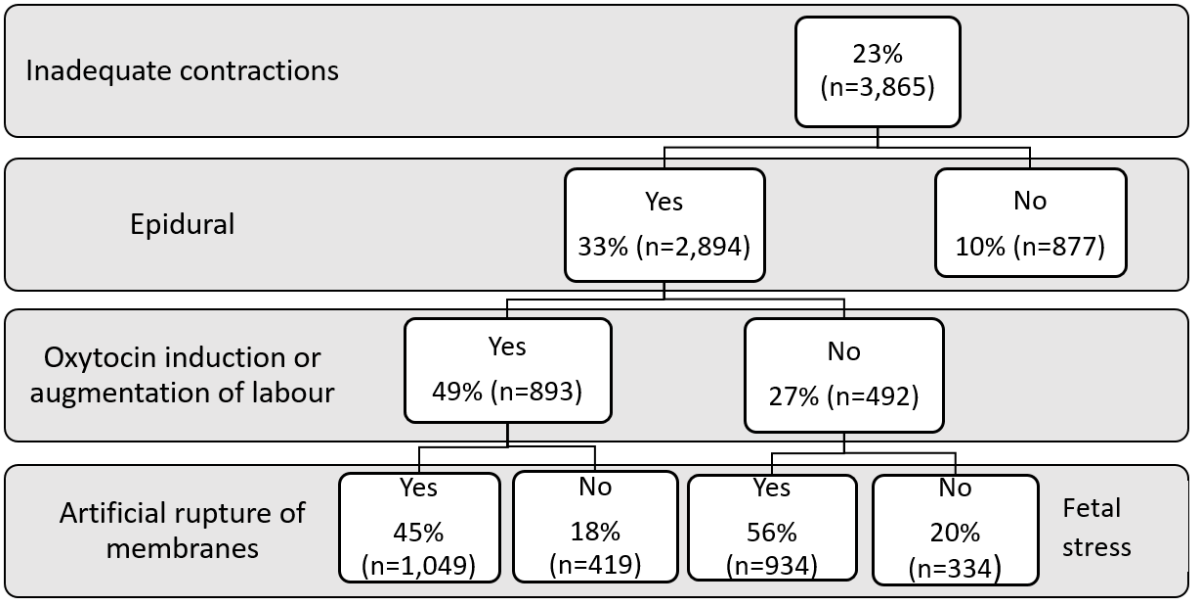

Figure 6.2: Prevalence (percentages) of primary inadequate contractions in mothers among classification tree subgroups.

Table 6.4. Variables of importance for primary inadequate contractions

Importance	Variable
1	Epidural analgesia
2	Artificial rupture of membranes
3	Fetal stress
4	Oxytocin augmentation or induction of labour

5	Obstructed labour

Discussion

This study aimed to better understand the drivers of primary CB in Queensland public hospitals. We found that only slight differences in maternal characteristics exist between mothers who had a primary caesarean and mothers who had a vaginal delivery. In addition, the demographic and clinical characteristics that are known to generate a higher risk for caesarean were not present among most mothers. The results of this study revealed that the most common reason for primary caesarean provision was not related to demographic and maternal risk factors. But rather, CB provision resulted from clinical conditions that were associated with epidural analgesia, oxytocin augmentation and induction of labour.

Analgesia is commonly used in Australia to relieve pain for women during labour. The use of epidural as pain relief has risen from 28% in 2000 (50) to 38% in 2017 (51). Whilst epidurals can provide pain relief for women, they do carry risks for both mother and baby. Epidurals have been shown to cause a decrease in fetal heart rate and poor quality contractions (270), as well as a prolonged first and second stage of labour (270, 271). The results of this study show that around half of primary caesareans in Queensland public hospitals were provided due to primary inadequate contractions and abnormal fetal heart rate. Epidural was the most important variable for predicting primary inadequate contractions and also an important variable for predicting an abnormal fetal heart rate in mothers who had a primary CB. Epidurals can cause considerable interference with the major hormones of labour; they may lower the production of natural oxytocin, which stimulates uterine contractions to help move the baby down the birth canal (272, 273). Such hormonal interferences may explain the more frequent use of synthetic oxytocin augmentation for women that have an epidural (273). Evidence-based information should be discussed with all service users during the perinatal period pertaining to the potential health risks and the possibly increased need for further medical or surgical intervention following an epidural, so that women can make informed choices during labour.

An important finding from this study is that induction of labour (AROM and oxytocin) is predictive of primary inadequate contractions and fetal heart rate anomaly, which were the top two reasons for primary CB provision in this study. The literature presents mixed findings on whether induction of labour increases or decreases the risk of CB at various weeks of gestation. Studies that used retrospective methods to compare induction of labour to spontaneous onset of labour report an increased risk of caesarean among women who were induced (212, 274-282). However, in studies

where induction of labour is compared to expectant management, a decreased risk of caesarean section has been found among women who had their labour induced in some (283-290), but not all studies (291-293). Some randomized controlled trials (39, 294) that compared planned induction of labour to expectant management found that mothers who had a routine induction of labour at 39 weeks gestation were less likely to deliver by caesarean. These trials use prospective study methods to compare two types of clinical options – induction versus no induction of low-risk women at 39 weeks gestation. Our study differed from such clinical trials in both its aims and study design as we used retrospective methods to determine which factors contribute to mothers receiving caesareans, thereby enabling us to describe observed trends in the clinical pathway to CB provision in the Queensland population. Further, the WHO recommends against the induction of labour for women with an uncomplicated pregnancy at a gestational age less than 41 weeks or in the absence of medical need due to its associated risks, which include uterine hyperstimulation and rupture, fetal distress, and the potential long term impacts of an earlier gestational delivery (295). There may be negative health and economic consequences associated with the uptake of routine induction at 39 weeks gestation (296).

A clinician may decide to augment or speed up labour by artificially rupturing a woman's membranes either before labour commences or if contractions have commenced, but have not provided enough pressure to rupture the membranes on their own, or by providing oxytocin, which can augment labour, speeding up contractions. It has been reported that within 9 to 12 minutes after artificial rupture of membranes, the fetus will often respond with violent and frequent movements alongside an alteration in fetal heart rate (297). Oxytocin may be used before an epidural, and as a result of the pain from the intensifying contractions, an epidural may be requested. In combination, epidural and oxytocin have been shown to result in higher use of caesareans (270). For example, the use of oxytocin to induce labour can accelerate contractions resulting in pain and increased use of epidural anaesthesia (298), which can lead to poor contractions, prolonged labour and potentially fetal stress (37). Once an epidural is in place, or electro fetal monitoring is used due to fetal stress, a women's ability to move about is restricted. The provision of interventions can further cascade and potentially lead to an instrumental or caesarean birth (271). The results of our study demonstrate that a cascade of birth interventions (oxytocin, AROM and epidural) are associated with fetal heart rate anomaly and primary inadequate contractions resulting in a primary caesarean birth. The provision of a primary caesarean then predisposes a woman to have a CB in subsequent births.

The strengths of this study include the use of a population-level dataset, which allows for the investigation of an entire population including all demographic and clinical details in addition to clinicians' reasons for performing a CB (299). Furthermore, the classification tree analysis was able to

segment the population into meaningful subsets. This allows for a review of contemporary policies and procedures in public healthcare settings and also for professional reflection on the practice of epidural and induction of labour in clinical practice, given the clear link that these have to CB. A limitation of this study is that we were limited by the variables available in the dataset. Clinical outcomes are not woman-centred, meaning that we were unable to capture whether the outcomes of importance to people giving birth were met, such as satisfaction with the birth process. Further, we were unable to examine provider and service-level factors surrounding the provision of interventions. Queensland Health does not currently collect information on the model of care that the woman received, and therefore, we cannot determine the care provider during the intrapartum period for the women in this study. Due to differences in practice patterns between care providers, this is an important determining factor of birth outcomes, including the use of intrapartum interventions (300), with a higher likelihood that mothers will receive an intrapartum intervention if they receive care from a physician as opposed to midwifery care (239, 301, 302). A final limitation of this study was that within the data, we were unable to differentiate between women who received routine fetal heart rate monitoring and those who received fetal monitoring due to clinical need. We found that 100% of women who had an abnormal fetal heart rate had fetal heart rate monitoring (as expected, as this is how an abnormal fetal heart rate is diagnosed). Therefore, we chose to exclude this variable from the analysis, and its impact on caesarean sections is worth investigating.

Conclusion

We found that the use of clinical interventions during labour and birth are driving the provision of CB in Queensland public hospitals. Understanding trends in primary and repeat caesareans and the potential drivers of these trends have provided important insights into target areas for reducing the overall caesarean rates in our region and beyond. The use of epidural and oxytocin induction or augmentation of labour may be in part responsible for initiating the 'cascade of interventions' that leads to a CB, and as such, warrants further investigation. Efforts should be made by health care providers during the antenatal period to maximize the use of preventative measures that minimize the need for medical interventions during normal, healthy childbearing.

Supplementary Files

Supplementary File 1: The "Cascade of interventions". Does it really exist?

Dear Editor,

I congratulate Fox et al on their recent publication in Birth (303) which addresses the underlying drivers of increasing rates of caesarean section. However, I believe the reported results do not lead to the conclusion that "the use of clinical interventions during labor and birth are driving the provision of [caesarean birth] in Queensland public hospitals." I am also concerned about the use of the phrase "a cascade of interventions". Retrospective studies can generally assess association, but not causation. I agree with the authors' conclusion that "caesarean section [may have] resulted from clinical conditions that were associated with epidural analgesia, oxytocin augmentation, and induction of labor". It is plausible that unknown factors or confounders (such as cephalo-pelvic disproportion) could directly cause prolonged labour, epidural analgesia, and caesarean section separately. The phrase "a cascade of interventions" seems to imply that one intervention inexorably leads to another and ultimately caesarean section. This phrase is imprecise and emotive and could create anxiety in women who may be offered appropriate interventions. It may be more useful to examine individual associations between interventions using the best epidemiologic evidence and use this information to facilitate informed decision-making. For example, the best evidence tells us that for both high and low risk pregnancies, induction of labour does not cause caesarean section, (290, 304-306) and the flaws in observational studies such as the use of inappropriate control groups led to the incorrect conclusion that it does (284). While it is reasonable to suspect that changes in practice (e.g., reluctance to recommend a difficult instrumental birth or to aim for a vaginal birth after previous severe perineal trauma) contribute to the rising rate of caesarean section, the story is complex. For example, there is evidence that most of the increase in caesarean sections can be attributed to changes in maternal factors and the management of preterm birth, non-cephalic presentation, and multiple gestation (307). The authors stated that "In combination, epidural and oxytocin have been shown to result in higher use of caesareans". However, the provided reference showed no difference in caesarean deliveries for women randomized to epidural compared with parenteral opioids (OR 1.00, 95% CI 0.77 to 1.28), and it did not compare oxytocin with no oxytocin in labour (270). I agree with the authors that interventions can lead to adverse consequences for women (308). An example is that higher-dose epidural analgesia increases the risk of instrumental birth, and that obstetric forceps are associated with anal sphincter injury (309). I also agree that more caesarean sections are performed than is necessary to achieve the best outcomes for mothers and babies. I would like to commend the authors on addressing the increasing rates of obstetric

intervention, a critically important issue in maternity care. While I disagree with some of their conclusions, this study is a step in the right direction. I believe ongoing collaboration and teamwork between midwives, obstetricians, and women who give birth will improve women's experience of birth and hopefully reduce obstetric interventions while achieving the best outcomes for women and babies.

Supplementary File 2: response to: The "Cascade of interventions". Does it really exist?

We write in reply to the letter *'The "Cascade of interventions". Does it really exist?*'. We thank the author for their reply to our previously published manuscript *A cascade of interventions: A classification tree analysis of the determinants of primary caesareans in Australian public hospitals (303)*. The findings of our study show that the top two reasons for primary caesarean section in Queensland public hospitals – abnormal fetal heart rate and inadequate contractions – were strongly associated with artificial rupture of membranes, induction of labour and epidural analgesia.

The intention of our manuscript was not to cause anxiety in women. But rather, to draw attention to the current drivers of caesarean sections. Our analysis revealed that decisions to perform artificial rupture of membranes, induction of labour and epidural analgesia - which are made as a part of the medical management of labour and birth - are underlying factors associated with primary caesarean section in Queensland public hospitals. Due to potential health risks associated with caesarean compared to a vaginal birth, (11) alongside women's preference for different modes of birth, (137) we also hoped that our study would give women insight into the factors associated with primary caesarean sections. Rather than causing anxiety, such information may empower women to ask their care provider questions during the antenatal period so that they can be fully informed, allowing women to then consider how they may feel about the possible outcomes associated with certain interventions. It is also important for women to be provided with information from their care providers about other potential options. For example, if women express that they wish to reduce pain during labour and birth, they may prefer to have a water birth if it is available to them, rather than receive an epidural. The intention of our study was not to stop women from receiving interventions where they are appropriate, informed and consensual, but rather to add to the evidence base to facilitate informed, shared decision-making.

The term cascade of interventions describes the tendency of interventions to accumulate during labour (310-312). Due to the retrospective nature of our study, and an inability to prove causation, our study simply demonstrates that obstetric interventions such as induction of labour, artificial rupture of membranes and epidural are dominant features preceding primary caesarean birth. Although the studies listed by the authors show induction of labour alone does not cause caesarean sections, this could be due to the proportion of caesarean sections in public hospitals being higher amongst women who receive a combination of interventions such as induction of labour and epidural (213). Further to the empirical evidence, anecdotal evidence surrounding the cascade of interventions has been persistently reported by health professionals for decades (313, 314).

Therefore, we feel that is an important topic that requires more in-depth research, including hearing the voices of women and their experiences and preferences. We agree that the story is complex and multi-faceted. However, we believe it is important to recognise the potential role of contemporary systems and culture of maternity care in Australia if we are to address the increasing rates of obstetric interventions.

Chapter 7: Drivers of caesarean sections in Australian private hospitals

Abstract

Objective:

To examine the drivers of primary caesarean sections for mothers who gave birth in Queensland private hospitals.

Study setting:

This project used a linked administrative healthcare dataset of all mothers (n=186,789) and their babies (n= 189,909) born between 2012 and 2015 in Queensland. We limited the dataset to all mothers who had a primary caesarean section in a private hospital. We reported the top 5 reasons for caesarean section and a decision tree was built to identify the major determinants of primary caesarean section.

Results:

Out of the 30,707 mothers who had no history of a previous caesarean section, 22.1% of births resulted in primary caesarean sections. The main drivers of primary caesarean section was 'delivery by elective caesarean section', followed by 'uterine inertia' and 'breech presentation'.

Conclusions:

Elective caesarean sections are the most important driver of primary caesarean sections in Queensland private hospitals. Twin pregnancy, abnormal fetal presentation, uterine inertia and assisted conception are also important driving factors.

Introduction

Caesarean section is a commonly used surgical procedure that can prevent maternal and neonatal morbidity and mortality when used for medically indicated reasons. However, there is a global concern for the rising rates of caesarean sections (11, 28), predominantly in middle and high-income countries, which have seen a sharp increase in non-medically indicated caesarean sections (28). The rates of caesarean section are not equally distributed between countries, population groups or health care sectors (28). From a global perspective, women who give birth under private care in middle and high-income countries have 1.8 times the odds of receiving a caesarean section compared to women who birth under public care (315).

In Australia, the rate of caesarean section is reflective of the global trend and is considerably higher in the private sector compared to the public sector and this gap is growing (49). Private hospitals in

Australia typically do not produce annual clinical reports making it difficult to obtain information around caesarean section rates in the private sector. However, the Australian Institute of Health and Welfare (AIHW) reports caesarean section rates for select mothers[17]. For this group of mothers, the rate of caesarean section has gone from 35% in the private sector and 24% in the public sector in 2007 to 40% in the private sector and 27% in the public sector in 2017 (49). Despite the rising rates of caesarean section over the past decade, the perinatal death rate has not shown a corresponding decline (316). Due to the lack of publically available data in the private sector, little is known about the reasons for the current rate of caesarean sections.

It has been suggested that higher intervention rates during labour and birth in the private sector are related to older maternal age (317). It is postulated that because women giving birth in the private sector are on average older (32.7 years) than women giving birth in the public sector (29.9 years) there are age-related risk-factors such as pre-eclampsia, gestational diabetes, (246) chromosome anomalies (262) infertility and the subsequential use of Assisted Reproductive Technology and multiple gestation pregnancies (261) that create a greater need for caesarean sections. The fertility rate among all age categories except for women aged 35-39 is declining in Australia, reflecting a shift towards later childbearing resulting in an increasing median age of mothers (318). Simultaneously, there has been a 44% increase in the number of Assisted Reproductive Technology cycles over the past decade, with mothers aged 35-39 having the largest increase in the use of Assisted Reproductive Technologies over this time period (319, 320). Age, Assisted Reproductive Technologies and their associated risk factors could partially contribute to the higher rates of caesarean section in the private sector. However, it has been shown that differences in caesarean section rates between the public and private sectors remain after adjusting for age (321). Therefore, age is not the only factor contributing to the differences.

Recently, Australia has started routinely collecting data on the reasons that a caesarean section is provided, which is documented by the clinician attending the birth (47). The AIHW reports that the most common reason for caesarean section in Australia is a history of previous caesarean section, with 86% of mothers having a repeat caesarean section in a subsequent birth to a primary caesarean section (51). However, to the best of our knowledge, the recorded reasons for *primary* caesarean section provision in the private sector have not been reported. Given the

higher rates of caesarean section in the private sector and the associated health (11) and economic consequences, (322) of caesarean sections compared to vaginal births, it is important to understand

[17] Primary caesarean section for women between 20 and 34 years who had a singleton birth between 37 and 41 weeks gestation, in the vertex presentation

the clinicians' reasons for providing a caesarean section. Therefore, the purpose of this study was to compare the demographic and clinical characteristics between women who had a primary caesarean section and women who had a vaginal delivery and examine the main reasons for primary caesarean section provision for all mothers and for mothers who conceived via Assisted Reproductive Technology methods in Queensland private hospitals.

Methods

The Australian Policy context

The Australian healthcare system includes a mix of public (universal health care) and private-sector care. All women are eligible for universal maternity care, which is provided in public hospitals. However, there is also the choice to take out private health cover. Private health insurance is voluntary and complementary to Medicare (Australia's universal health scheme). Currently, 44% of the population in Australia has private health insurance (323). The uptake of private health insurance has been encouraged by the Federal Government via the introduction of a range of incentives and penalties (324). Some examples of incentives and penalties include the Private Health Insurance Incentive Schemes (PHIIS), which includes age-adjusted, means-tested rebates for private health insurance premiums; tax penalties (the 'Medicare Levy Surcharge') for higher-income earners who do not take out insurance, and premium surcharges for people who take out private health insurance after age 31 (324). The private health insurance industry is highly concentrated with only five insurance funds accounting for more than 80% of all policies, with almost 70% of the industry now operating on a for-profit basis (325). Private hospitals are owned and operated by the private sector, however, they are licensed and regulated by governments (325). Public hospitals are managed by state and territory governments and most out of hospital services, such as those provided by obstetric specialists, are delivered by private providers (325). Women who have private health cover and choose to use it during childbirth can do so as either a private patient in a public hospital or a private patient in a private hospital. Specialist obstetricians can practice privately in either a public or private hospital. If they treat public patients in a public hospital they are remunerated by the public hospital on a salary basis. If they treat private patients in either a public or private hospital they are able to determine their own fees and receive fee-for-service payment from the patient. Women may also choose to give birth in a private hospital as a private patient without private health insurance and self-fund their stay.

Approximately 32% of mothers who give birth in Australia do so under the private obstetric model of care (97). The private obstetric model of care allows for a choice of obstetrician, guaranteed continuity with this carer and typically has shorter appointment waiting times. This model of care

includes antenatal care, which is provided by a private specialist obstetrician, intrapartum care, which is provided in a hospital by the private specialist obstetrician and hospital midwives in collaboration and postnatal care, which is typically provided in the hospital by the private specialist obstetrician and hospital midwives and may continue in the home (326). In this study, we have included all mothers who gave birth in a private facility and therefore, under the care of a private obstetrician in Queensland, Australia.

Data

This project utilised a whole of population linked dataset called Maternity1000 (99). Maternity1000 uses the Queensland Perinatal Data Collection (PDC) to identify all mothers who gave birth in Queensland, and currently contains the records of mothers who gave birth between 1st July 2012 and 30th June 2015 (n=186,789), plus their resultant babies (n= 189,909).

All individuals were identified from the Queensland Perinatal Data Collection (PDC) and Queensland Birth Registry by Queensland Health's Statistical Services Branch (SSB). The records were then linked to Queensland Hospital Admitted Patient Data Collection (QHAPDC), Deaths Registry, Emergency Department Information System (EDIS) and Hospital and Health Service (HHS) Funding and Costing Unit records between 2012 and 2015. The records were then linked by the Australian Institute of Health and Welfare (AIHW) to Medicare Benefits Schedule (MBS) and Pharmaceutical Benefits Scheme (PBS) claims records. For this study, we utilized inpatient hospital data from the QHAPDC, the Queensland PDC and MBS datasets and the population were limited to all mothers who gave birth in a private hospital and had no history of previous caesarean section.

ICD-10-AM

To categorise maternal health conditions, obstetric complications, procedures performed and to report the clinician recorded reasons for primary caesarean section provision in private health care facilities, the ICD-10-AM 8th Edition was used (182). ICD-10-AM is the International Statistical Classification of Diseases and Related Health Problems, Australian Modification. The ICD-10-AM is a derived version of the WHO ICD-10ICD-10-AM, which was developed by the National Centre for Classification in Health.

Maternal Characteristics

To compare the differences in maternal characteristics contributing to caesarean section provision in the private sector, we report the maternal characteristics of mothers who received a primary caesarean section and women that had a vaginal birth (with no history of previous caesarean section). Variables including Body Mass Index (BMI), postcode, Aboriginal and Torres Strait Islander Status, and assisted conception are recorded on the Queensland Perinatal Data Collection.

As per the World Health Organization, a BMI of <18.5 is considered underweight; 18.5-24.9 is considered to be a healthy weight, 25.0-29.9 is considered overweight; and >30 is considered to be obese (267). We categorised mothers' socioeconomic status using the Index of Relative Socioeconomic Disadvantage (IRSD), which is based on mothers' postcode of residence at the time of birth (118). Mothers who identified at antenatal visits as either Aboriginal and/or Torres Strait Islander were recorded on the Queensland Perinatal Data Collection. We used the Australian Bureau of Statistics (ABS) Accessibility/Remoteness Index of Australia (ARIA+) to categorise mothers' rurality based upon their postcode of residence at the time of birth (119). Assisted conception is recorded on the QPDC as either a pregnancy that was achieved by Artificial Insemination, Ovulation Induction, In Vitro Fertilisation, Gamete Intrafallopian Transfer, Intracytoplasmic Sperm Injection, Donor Egg, or Embryo Transfer.

If mothers in the linked dataset had an ICD-10-AM code that included either pre-existing diabetes mellitus or diabetes mellitus in pregnancy they were classified as 'diabetes during pregnancy'. If mothers had an ICD-10-AM code that included either gestational hypertension, chronic hypertension, pre-eclampsia, eclampsia, or preeclampsia superimposed on chronic hypertension they were classified as 'Hypertensive Disorders of Pregnancy'.

Statistical analysis

To establish which factors might contribute to the provision of a caesarean section in Queensland private hospitals, we compared the frequency and percent of demographic and clinical characteristics between mothers who had a primary caesarean section and vaginal delivery (no history of previous caesarean section) in Queensland private hospitals between 2012 and 2015.

The frequency and percentage of the top 5 reasons recorded by clinicians for a primary caesarean section as per the ICD-10-AM codes were also reported. To gain better insight into the reasons that mothers who conceive via Assisted Reproductive Technology have a caesarean section, we further limited the population to all mothers who had a primary caesarean section and conceived via Assisted Reproductive Technology and reported the top 5 reasons recorded by clinicians for a primary caesarean section for this group of mothers. Only one reason can be reported per woman, therefore, these groups are exclusive of one another.

A decision tree was built to identify the most important determinants of primary caesarean section in Queensland private hospitals. The decision tree uses a machine-learning algorithm to identify mutually exclusive and exhaustive subgroups of a population whose members share common characteristics that influence the dependent variable of interest (269). The decision tree method tests whether a given correlate and a dependent measure are associated while controlling for

confounding factors. An extensive list of maternal health and clinical characteristics were included in the model (see appendix 7) as independent (predictor) variables and 'Primary caesarean section' was the dependent variable. Observations for which the response variables were missing were omitted from the analysis. A variables of importance procedure was performed as part of the classification tree analysis, which selects the most useful independent variables for predicting the dependent variable, as important variables may not be near the top of the classification tree (268). Each individual node within the classification tree adds up to 100% of either 'yes' or 'no' for the dependent variable. In our results, we present only the percentage of 'yes' as having the dependent variable and we do not present the percentage that were 'no' and did not have the dependent variable.

All analysis was undertaken using SAS9.4 statistical software.

Results

Table 7.1 shows the demographic and clinical characteristics of mothers who had a primary caesarean section compared to mothers who had a vaginal delivery with no history of previous caesarean section in Queensland private hospitals. Out of the 30,707 mothers who had no history of previous caesarean section, 22.1% of births resulted in a primary caesarean section and 77.9% were a vaginal birth.

The majority of mothers in both groups were aged between 30-40 years, making up 81.5% of mothers who had a primary caesarean section and 79.7% of mothers who had a vaginal birth. More than half of mothers in both groups were within the healthy weight range, making up 57.6% of mothers who had primary caesarean section and 62.6% of mothers who had a vaginal birth. The percentage of mothers that had an assisted conception was higher among mothers who had a caesarean section (21.6%) compared to mothers who had a vaginal delivery (9.1%); the rate of twins was higher for mothers who had a caesarean section (10.3%) compared to mothers who had a vaginal delivery (1.7%), and the rate of breech presentation was higher for mothers who had a caesarean section (9.8%) compared to mothers who had a vaginal delivery (0.5%).

Table 7.1. Characteristics of women who had their first caesarean section compared to women who had a vaginal delivery and no previous caesarean section

Characteristics	**Primary caesarean section n (%)**	**No previous caesarean section and vaginal delivery n (%)**
Total	6,793 (22.1)	23,914 (77.9)
Age		
<25	184 (2.7)	584 (2.4)
25-29	1,075 (15.8)	4,286 (17.9)
30-34	2,711 (39.9)	10,659 (44.6)
35-40	2,006 (29.5)	6,956 (29.1)
40+	817 (12.1)	1,429 (6)
BMI		
<18.00	245 (3.7)	1,206 (5.1)
18.5–24.9	3,818 (57.6)	14,818 (62.6)
25.0–29.9	1,601 (24.2)	5,115 (21.6)
30.0–34.9	671 (10.1)	1,885 (8)
35.0–39.9	291 (4.4)	630 (2.7)
SEIFA		
Most disadvantaged	202 (3.1)	639 (2.7)
2	860 (13)	3,364 (14.4)
3	1,087 (16.5)	3,778 (16.2)
4	1,797 (27.2)	5,747 (24.6)
Least disadvantaged	2,646 (40.1)	9,845 (42.1)
Indigenous status		
Yes	37 (0.5)	86 (0.4)
No	6,756 (99.5)	23,828 (99.6)
Rurality		
urban	4,116 (62.4)	14,301 (59.8)
Inner regional	11,004 (5.3)	3,515 (14.7)
Outer regional	1,000 (15.2)	3,898 (16.3)
Remote	354 (5.4)	1,650 (6.9)
Very remote	118 (1.8)	550 (2.3)

Assisted Reproductive Technology		
Yes	1,469 (21.6)	2,167 (9.1)
No	5,324 (78.4)	21,747 (90.9)
Hypertensive Disorders of Pregnancy		
Yes	226 (3.3)	778 (3.3)
No	6,576 (96.7)	23,136 (96.8)
Diabetes during pregnancy		
Yes	674 (9.9)	1,783 (7.5)
No	6,119 (90.1)	22,131 (92.5)
Tobacco smoking		
Yes	157 (2.3)	351 (1.5)
No	6,630 (97.7)	23,538 (98.5)
Congenital malformations		
Yes	267 (3.93)	758 (3.2)
No	6,526 (96.1)	23,156 (96.8)
Plurality		
Singleton	6,078 (89.5)	23,500 (98.3)
Twins	698 (10.3)	401 (1.7)
Triplets or more	17 (0.2)	13 (.05)
Presentation		
Vertex	5,529 (81.4)	23,615 (98.8)
Breech	996 (14.7)	123 (0.5)
Other	268 (3.9)	176 (0.7)

Table 7.2 shows the top 5 reported reasons for primary caesarean section in Queensland private hospitals for all mothers and mothers who conceived via Assisted Reproductive Technology. The most frequently reported reason for performing a primary caesarean section for all mothers was 'delivery by elective caesarean section', followed by 'other uterine inertia' and 'maternal care for breech presentation'. The most frequently reported reasons for primary caesarean section for mothers who conceived via Assisted Reproductive Technology were 'delivery by elective caesarean section', followed by 'twin pregnancy' and 'uterine inertia'.

Table 7.2. Top 5 reasons for primary caesarean section in QLD

Category title (ICD-10 code)	**N (%)**
All primary caesarean sections	
Delivery by elective caesarean section[18] (O82)	1,248 (18.37%)
Other uterine inertia (O622)	657 (9.67%)
Maternal care for breech presentation (O321)	620 (9.13%)
Twin pregnancy (O300)	352 (5.91%)
Labour and delivery complicated by fetal stress, unspecified (O689)	384 (5.66)
Labour and delivery complicated by fetal heart rate anomaly (O680)	349 (5.41%)
Primary caesarean sections for Assisted Reproductive Technology conceived pregnancies	
Delivery by elective caesarean section (082)	259 (17.5)
Twin pregnancy (O300)	182 (12.3)
Other uterine inertia (O622)	151 (10.2)
Maternal care for breech presentation (O321)	110 (7.5)
Labour and delivery complicated by fetal heart rate anomaly (0680)	55 (3.7)

The classification tree analysis of 'primary caesarean section' is presented in Figure 7.1. Amongst the sample of mothers who had a caesarean section, 21% had a primary caesarean section. The classification tree analysis of 'primary caesarean section' generated a tree containing 6 terminal nodes. Within this sub-sample, primary caesarean sections were most probable in the private sector due to elective caesarean sections (100%), inadequate contractions (100%) and abnormal fetal presentation (80%). Elective caesarean section, inadequate contractions, abnormal fetal presentation, abnormal fetal heart rate, and multiple gestations were the top 5 variables in the variables of importance analysis (Table 7.3).

[18] A caesarean section that is planned before labour commences.

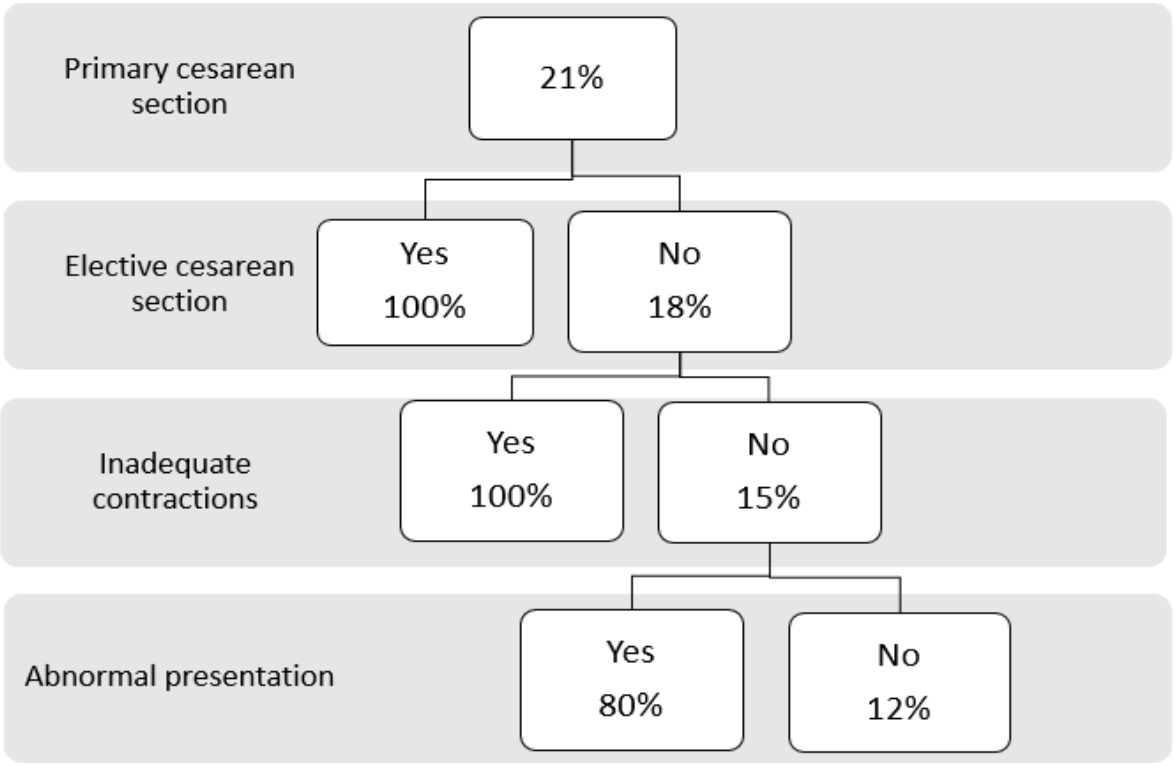

Figure 7.1: Prevalence (percentages) of primary caesarean section in mothers among classification tree subgroups

Table 7.3. Top 5 variables of importance for primary caesarean section in Queensland private hospitals.

Importance ranking	**Variable**
1	Elective caesarean section
2	Inadequate contractions
3	Abnormal fetal presentation
4	Abnormal fetal heart rate
5	Multiple gestation

Discussion

The aim of this study was to gain an understanding of the drivers of caesarean section provision in Queensland private hospitals. The results present several findings. The first finding is that elective caesarean sections are the most important driver of primary caesarean sections in Queensland

private hospitals. The second finding is that twin pregnancy and abnormal fetal presentation were major clinical determinants of primary caesarean section provision. Similarly, the main differences in maternal characteristics between mothers who had a primary caesarean section and mothers who had a vaginal delivery were that mothers who had a caesarean section had higher rates of assisted conception, twins and abnormal fetal presentations. The majority of mothers in both groups were within a healthy weight range, were under 35 years of age, were non-indigenous, residing in urban areas, and living in the highest socioeconomic conditions, which are typically population groups that have lower rates of maternal risk factors and therefore, in need of fewer medical interventions (51, 113). Furthermore, there were no great differences in rates of hypertension and diabetes, which are known to increase the likelihood of caesarean section (158, 327).

Our results revealed that mothers who had a caesarean section were 137% more likely to have conceived via Assisted Reproductive Technology compared to mothers who had a vaginal birth. The top two reasons recorded by clinicians for primary cesaraen section for mothers who conceived via Assisted Reproductive Technology were having an elective caesarean section, followed by twin pregnancy. These findings fly in the face of frequent suggestions (243) that the increasing rate of caesarean section is due to the changing risk profiles of birthing women such as increasing age of first birth, infertility and subsequential assisted conception. Yet, assisted conception is not a direct medical reason for performing a caesarean section. Rather, Assisted Reproductive Technology can increase the likelihood of pregnancy risk factors such as preeclampsia, placental abruption (4), preterm birth (328), low birth weight and stillbirth (329). However, these medical risk-factors were not recorded by clinicians as top reasons for providing caesarean sections. It has been postulated that there is a lower clinical threshold for performing caesarean sections among obstetricians for Assisted Reproductive Technology conceived pregnancies, which could be a reflection of our results that showed that elective caesarean section was the top reason for performing a caesarean section for mothers who conceived via Assisted Reproductive Technology. This practice has been described as the “precious baby” effect, whereby the obstetrician modifies their practice based on the knowledge that the pregnancy is the result of Assisted Reproductive Technology (330). Such an approach presumes that a caesarean section is the least risky mode of birth, even where not medically indicated. This assumption is contradicted by current evidence.

Further, our results showed that multiple gestation pregnancy is an important variable for driving caesarean section provision in private hospitals for both mothers who conceived via Assisted Reproductive Technology and those who conceived naturally. A multiple gestation pregnancy has an increased likelihood of complications such as Intra Uterine Growth Restriction (IUGR), pre-eclampsia, gestational diabetes, congenital anomalies, malpresentation and cord prolapse (331). Therefore,

multiple gestation pregnancies place women in a 'high risk' category, predisposing them to caesarean delivery. Despite evidence suggesting that planned caesarean section does not significantly improve maternal and neonatal outcomes in multiple gestation pregnancies (332), the rate of caesarean section among multiple gestation births is increasing in Australia (51), with higher rates experienced in the private sector (29.1%) compared to the public sector (14.1%) (333). Differences in caesarean section rates between the public and private sectors among mothers of multiple gestations may be due to health service or health provider factors that differentiate the public and private sector, resulting in a limitation of the choice of mode of birth for mothers in the private sector (334). Further examination is required to better understand the differences in decision making to provide a caesarean section for specific groups of mothers such as those who conceive via Assisted Reproductive Technology or mothers who have multiple gestation pregnancies between Australia's public and private maternity care system.

The results of our study show that breech presentation is also a key driver of caesarean sections in Queensland private hospitals. Vaginal breech birth rates have decreased considerably from 23.1% in 1991 (335) to 4.0% in 2010 (336) following the release of results from the Term Breech Trial, which concluded that planned caesarean section was safer than planned vaginal birth for babies in the breech presentation (337). Consequently, the rates of caesarean section among breech presentations increased in many parts of the world, which has led to a decline in clinical expertise in managing vaginal breech births (338). Researchers have since identified substantial flaws in the design and recommendations of this trial (339), and subsequently, high-level evidence has been produced that concludes that with the use of sound selection criteria and an experienced practitioner, a vaginal breech birth can be a safe and successful option for mothers (340). With a reduction in practitioners having adequate exposure and experience managing vaginal breech births, pregnant women with a breech presentation at term might have a limited choice of mode of birth. These women should be given evidence-based information to ensure they can make an informed decision regarding the mode of birth and management options, including access to a vaginal breech birth at a facility that has adequate expertise if it is possible and suitable for the mother.

The final key finding from this study was that elective caesarean was the most important reason mothers had a caesarean section in Queensland private hospitals. There is no doubt that access to emergency caesarean sections can prevent morbidity and mortality for both mother and baby when clinically necessary. However, the rates of both emergency and elective caesarean sections have increased in Australia, with a greater rise seen in elective caesarean sections (224). Data from 2015 shows that 60% of elective caesarean sections are performed at 37 to less than 39 weeks gestation and 20% are performed at less than 37 weeks gestation for privately funded patients. These figures

are substantially higher than in the public sector (341). A commonly proposed reason for the rising rates of caesarean sections is maternal request (342). Currently, a limited understanding of women's preferences for mode of birth exists. The last study to report the prevalence of maternal request for caesarean section in Australia was conducted in 2001, which demonstrated only 6.4% of women preferred a cesaran section compared to vaginal birth (137). Women considering an elective caesarean section have reported that their doubts and fears about labour and delivery were reinforced and their choice for a non-medically indicated elective caesarean section was readily accepted and encouraged by their doctor (343). Other studies have reported that pregnant women frequently identify health providers as the most important influence in regards to the choice of mode of birth (344) pointing to the need for further research to understand more about public and provider service providers' own preferences and recommendations. For women who experience fears and doubts surrounding labour and vaginal birth, health providers must be equipped and confident to be able to support women by having evidence-based discussions that can help alleviate fears and promote confidence so that women feel adequately supported. With our results demonstrating that a high proportion of primary caesarean sections are elective (planned before labour commences), a greater understanding of maternal and clinician interactions and factors specific to the private sector is required.

The strength of this study is the use of a population-level dataset, which allows for an investigation of an entire population including all demographic and clinical details and clinicians' reasons for performing a caesarean section. The limitation of this study is that we were limited by the variables available in the dataset and we were unable to examine mothers' perspectives and their satisfaction with their birth process for those who received an elective caesarean section.

The prevalence of elective caesarean section without medical indication raises concern due to the increased physical and emotional health risks as compared to vaginal birth. As first birth by caesarean section is a strong determinant for caesarean section in subsequent pregnancies, it is important that women who conceive with Assisted Reproductive Technology, and those who experience multiple gestation pregnancies and breech presentation are adequately informed by their maternity care providers about the potential risks and benefits of caesarean section compared to a vaginal birth relevant to their individual needs and are properly supported during this time.

Summary of Section 3

This section addressed research question 2 of the thesis: *What are the clinical drivers and health provider reasons for providing caesarean sections in Queensland public and private hospitals?* The two main clinical drivers of primary cesaresan section provision in public hospitals – abnormal fetal heart rate and inadequate contractions, which account for almost half of the women receiving caesarean sections – were found to primarily be caused by the use of obstetric interventions including the artificial rupture of membranes; oxytocin induction or augmentation of labour and epidural analgesia.

Evidence-based information should be provided to women by their health care provider during the antenatal period on the potential risks associated with medical interventions during labour and birth, such as epidural and oxytocin and the increased likelihood of having a caesarean section so that women can make informed decisions about their birth. When providing interventions such as epidural, artificial rupture of membranes, and oxytocin, clinicians need to take into consideration the longer-term implications such as the potential subsequent need for a caesarean section, which initiates a cycle of repeat caesarean sections in future births. Maternal health care providers need to provide education to women during the antenatal period about preventative measures that minimize the need for medical and surgical intervention during birth, and make these options routinely available. For example, water immersion during labour and birth to help with pain relief instead of an epidural for analgesia. Future research should consider the health provider and health service-level factors that surround the provision of obstetric interventions.

Elective caesarean section was found to be the most common clinician recorded reason for providing a primary caesarean section in the Queensland private sector. Twin pregnancy, fetal mal-presentation, and the use of Assisted Reproductive Technologies were major clinical determinants for providing primary caesarean sections in Queensland private hospitals. Generally, there was not a great difference in maternal characteristics between women that had a caesarean section and women that did not. Specifically, there was no great difference in clinical conditions that can increase the likelihood of needing a caesarean section. However, higher rates of assisted conception, twins, and abnormal fetal presentations were present in women that had a caesarean section.

Women giving birth in the private sector should be given evidence-based information during the antenatal period, which should particularly be targeted at women who conceive via Assisted Reproductive Technology, have a multiple gestation pregnancy, and women whose baby is in the breech position so that women can make an informed decision regarding the mode of birth and management options. If health providers are not experienced and confident with vaginal breech

deliveries or twin deliveries, referrals could be made so that if a woman does want to have a vaginal birth and there is a service available, she can do so. Future research should consider the interaction between health providers and women to better understand why women without clinical indication are receiving caesarean sections and also a greater understanding of private providers' birth preferences.

This concludes Section 3 of the thesis and leads to Section 4, which will examine the influence that macro-level financing policies have on the provision of maternal health care and health services to gain a deeper understanding of the potential health system factors that are contributing to the trends observed in sections 2 and 3 of the thesis.

Section 4: Macro-level health and economic policy levers of maternity care provision

This section of the thesis addresses research question number 3: *In what ways have macro-level health and economic policies influenced the management of maternal health care in Australia?* Section 4 contains one published paper. Chapter 8 is a scoping review and interpretative synthesis of the financing mechanisms and their impact on the delivery of maternity care in Australia.

The publication included in this section of the thesis include:

- **Fox H**, Topp SM, Callander E, Lindsay D. A review of the impact of financing mechanisms on maternal health care in Australia. *BMC public health*. 2019;19(1):1540. DOI: https://doi.org/10.1186/s12889-019-7850-6

Section 1: Introduction and methods

Chapter one: Introduction

Chapter two: Methods

Section 2: Inequities in maternal health service provision

Chapter three: Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers

Fox H, Callander E, Lindsay D, Topp S. Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers. *BMC Pregnancy and Childbirth*. 2019;19(1):226. DOI: https://doi.org/10.1186/s12884-019-2369-5

Chapter four: Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia.

Fox H, Topp S, Lindsay D, Callander E. Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia. *International Journal of Health Planning and management*. Under review. 2021.

Chapter five: Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals.

Fox H, Callander E, Lindsay D, Topp S. Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals. *Australian Health Review*.2021; DOI: https://doi.org/10.1071/AH20014

Research question 1

Section 3: A case study of the determinants of caesarean section provision in Queensland hospitals.

Chapter six: A cascade of interventions: determinants of caesarean sections in Australian public hospitals.

Fox H, Topp S, Lindsay D, Callander E. A cascade of interventions: determinants of caesarean sections in Australian public hospitals. *Birth.* 2021. DOI: https://doi.org/10.1111/birt.12530

Chapter seven: Drivers of primary caesarean sections in Australian private hospitals..

Fox H, Topp S, Lindsay D, Callander E. Determinants of caesarean sections in Australian private hospitals. *Midwifery*. Under review. 2021.

Research question 2

Section 4: Macro-level healthcare financing policy levers of maternal health care

Chapter eight: A review of the impact of financing mechanisms on maternal health care in Australia

Fox H, Topp SM, Callander E, Lindsay D. A review of the impact of financing mechanisms on maternal health care in Australia. BMC public health. 2019;19(1):1540. DOI: https://doi.org/10.1186/s12889-019-7850-6

Research question 3

Section 5: Discussion and conclusion

Chapter nine: Discussion and conclusion

Chapter 8: A review of the impact of financing mechanisms on maternal health care in Australia

Abstract

Background

The World Health Organization states there are three interrelated domains that are fundamental to achieving and maintaining universal access to care - raising sufficient funds for health care, reducing financial barriers to access by pooling funds in a way that prevents out-of-pocket costs, and allocating funds in a way that promotes quality, efficiency and equity. In Australia, a comprehensive account of the mechanisms for financing the health system have not been synthesised elsewhere. Therefore, to understand how the maternal health system is financed, this review aims to examine the mechanisms for funding, pooling and purchasing maternal health care and the influence these financing mechanisms have on the delivery of maternal health services in Australia.

Methods

We conducted a scoping review and interpretative synthesis of the financing mechanisms and their impact on Australia's maternal health system. Due to the nature of the study question, the review had a major focus on grey literature. The search was undertaken in three stages including; searching (1) Google search engine (2) targeted websites and (3) academic databases. Executive summaries and table of contents were screened for grey literature documents and Titles and Abstracts were screened for journal articles. Screening of publications' full-text followed. Data relating to either funding, pooling, or purchasing of maternal health care were extracted for synthesis.

Results

A total of 69 manuscripts were included in the synthesis, with 52 of those from the Google search engine and targeted website (grey literature) search. A total of 17 articles we included in the synthesis from the database search.

Conclusion

Our study provides a critical review of the mechanisms by which revenues are raised, funds are pooled and their impact on the way health care services are purchased for mothers and babies in Australia. Australia's maternal health system is financed via both public and private sources, which consequentially creates a two-tiered system. Mothers who can afford private health insurance – typically wealthier, urban and non-First Nations women - therefore receive additional benefits of

private care, which further exacerbates inequity between these groups of mothers and babies. The increasing out of pocket costs associated with obstetric care may create a financial burden for women to access necessary care or it may cause them to skip care altogether if the costs are too great.

Background

The architecture of health care financing affects how a health system performs and a country's ability to achieve the goals of universal health coverage for all mothers and babies (345-347). There are many mechanisms (e.g., tax revenues, non-tax revenues, external grants or loans, out of pocket payments and voluntary health insurance) for financing of maternal health services (345). However, predominantly relying on public, versus private funding sources is considered to be a more progressive method for financing a health system (348). The World Health Organization (WHO) has stated that countries primarily relying on public sources make greater progress towards universal health coverage (349), although notable exceptions exist. The French health system, for example, with publically subsidised supplementary private health insurance for over 90% of the population has some of the lowest out of pocket costs in the Organization for Economic Co-operation and Development (OECD) and falling (350). Public revenues enable risk-sharing between the rich and the poor and between those who are healthy and those who are sick in society. Consequentially, this enables health systems to improve access to maternal health services, with financial protection for all. When health systems rely upon private funding sources, and mothers have to pay for health services out-of-pocket, some mothers and babies will not be able to access the health services that they need (349).

Globally, Australia has one of the highest rates of per-capita out-of-pocket healthcare expenditure (351), despite having a universal health insurance scheme (Medicare) in place for over 30 years (352). Out-of-pocket costs that can be incurred when people access general practitioners, specialists, allied health care services, medical care at private hospitals and pharmaceuticals, causing people to either delay or forego accessing necessary health care, with the greatest financial strain felt by those with lower incomes (353, 354). This may be particularly felt by those accessing maternal health care, as the out of pocket charges for obstetric-related services have increased far more rapidly than other areas of care (90). The Australian Institute of Health and Welfare (AIHW) stated that in some areas of healthcare there has been a decrease in government financial contributions, resulting in costs being transferred onto individuals in the form of out-of-pocket payments (325).

The WHO states there are three inter-related domains that are fundamental for moving towards universal health coverage, including; raising sufficient funds for health care, reducing financial

barriers to access by pooling funds in a way that prevents out-of-pocket costs, and allocating funds in a way that promotes quality, efficiency and equity (355). Advancements in these three areas will be important factors in determining whether health services are available for everyone, irrespective of ability to pay (355). Understanding how Australia's maternal health system is financed is essential for identifying if there are areas of inadequacy within healthcare financing policy that might affect the ability of mothers and their babies to access necessary care. Based on the WHO's fundamental domains for achieving universal health coverage, this review will explore the funding[19], pooling[20], and purchase[21] of maternal health services in Australia.

Methods

A scoping review and interpretative synthesis drawing on electronic and non-electronic materials was conducted to characterise the current health financing mechanisms of maternal health care in Australia. In this study, we grouped the financing mechanisms under separate headings of 'Funding', 'Pooling', and 'Purchasing', and drawing on both primary and secondary sources asked:

1. What are the mechanisms for funding, pooling and purchasing maternal health care in Australia?

2. How do financing mechanisms influence the delivery of maternal health services in Australia?

Due to the nature of the study question, this study focused on searching primary sources sometimes referred to as 'grey literature' as well as peer-review publications. Grey literature includes 'that which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers' (356). Some methods for grey literature searches have been described in the literature (357-361), however, no 'gold standard' for grey literature have been developed. The Cochrane Handbook, which is an official guide for undertaking systematic reviews, provides insufficient guidance for searching grey literature (362). In order to ensure transparency of study findings, the authors drew on one methodological study (361), which provided the most comprehensive details for applying systematic review search methods to the grey literature that adheres to the Preferred Reporting Items for Systematic Reviews and Met-Analyses (PRISMA) guidelines (363). A review protocol was not developed and this review was not registered.

Eligibility criteria

[19] Funding refers to government policies that are in place to raise revenues to pay for the operations of the health care system
[20] Pooling refers to the accumulation of funds on behalf of the population for transfer to health care providers
[21] The purchasing of health services refers to the allocation of pooled funds to health care providers that deliver health care goods and services

Documents considered for inclusion in the study were those that were published in English, if they were the most recent version of the document, and contained any information on the funding, pooling, or purchasing of health care in Australia that is applicable to maternal health. The first literature search was conducted between October and December, 2017 and included the time period of 2000 to 2017. The review was updated in July 2019 to include the information from 2018 to the date of the literature search.

Information sources and searching strategies

The document and source search incorporated three different search strategies. The first two strategies were of the grey literature, which included searching (1) Google search engine (Chrome) and (2) targeted websites. The third search strategy was a traditional systematic review of (3) academic databases.

Due to the nature of the internet, it is impractical to screen all results produced by Google. Google uses algorithms to rank the importance of website pages relevant to the search terms (364), allowing for narrow and specific searching, which was relied upon for producing relevant results. Therefore, the researchers screened the first 10 pages (a total of 100 pages per search). Advanced search engine searching methods that only included specific websites ending in specific suffixes was conducted using the following suffixes:

- :gov.au
- :edu.au
- :int.
- :org

Using these suffixes the following keywords and phrases included in the search were*: Healthcare, costs, fees, Charges, Expenditure, Out of pocket, Healthcare financing, Health policy, Health expenditures, Funding, Healthcare reform, Universal Health Coverage, Resource allocation, Financial management, Federal Government, State and Territory Government, Economics, Maternal Health Services, Pregnancy, Labour, Birth, Obstetric, Midwife, Model of Care, Hospital, Delivery of Health Care, Revenue raising, Tax, Pooling, Funding, Purchasing, Medicare and Australia*. The keywords were combined in different formats using OR and AND. An example of a search strategy used in the Google search was:

Medicare AND Australia:gov.au

The second search strategy involved the first author searching specific websites of applicable health, research, and government organisations. Firstly, the author searched Google to establish websites that contained relevant information for addressing the research question. Each of the websites identified was then hand searched via the websites search bar. The grey literature search was conducted between October 23rd and December 20th, 2017.

The third search strategy was of academic databases. The first author searched titles, abstracts, and keywords in CINAHL, Informit, Cochrane Library, and Scopus databases during the month of November 2017 to obtain peer-review journal articles that met the inclusion criteria. The same keywords used in the first search strategy were used in the database search by combining different words using "OR", "AND" and Truncation (*). A search strategy used in Scopus is presented in Table 8.1. Manuscripts were excluded at this stage of the search if they were unrelated to the Australian healthcare system or if a more relevant manuscript was available detailing similar information. After title and abstract screening, the full texts were imported into Endnote and duplicates were removed.

Table 8.1: Search strategy, Scopus

	Search strategy	Results
1	TITLE-ABS-KEY ("Federal Government")	30,049 document results
2	TITLE-ABS-KEY ("Health expenditure*")	20,459 document results
3	TITLE-ABS-KEY (austral*)	565,915 document results
4	(TITLE-ABS-KEY ("Federal Government")) AND (TITLE-ABS-KEY ("Health expenditure*")) AND (TITLE-ABS-KEY (austral*))	7 document results

Eligibility assessment and study selection

The PRISMA flow diagram was also applied to the grey literature search. It is uncommon for grey literature to have abstracts (357), therefore, executive summaries, table of contents or subheadings were screened. The first author approached this stage in a conservative manner and continued screening the document or web page further to assess for relevance if the review question was not

explicitly addressed, but still warranted further investigation. The details of the documents and web pages were manually entered into an Excel file. The information included in the data extraction was the source organisation, title, date published, URL and any information relating to the funding, pooling of purchasing of maternity care services in Australia were entered under these headings. The final documents were downloaded in full to ensure they addressed the research questions. A total of 52 documents and web pages in the grey literature search were included in the review. The combination of the three search strategies resulted in a total of 69 documents and web pages. The researchers found that if they had of relied solely on academic databases for the source of information 75% of the manuscripts would not have been identified. Refer to Appendix 8 for all documents included in this review.

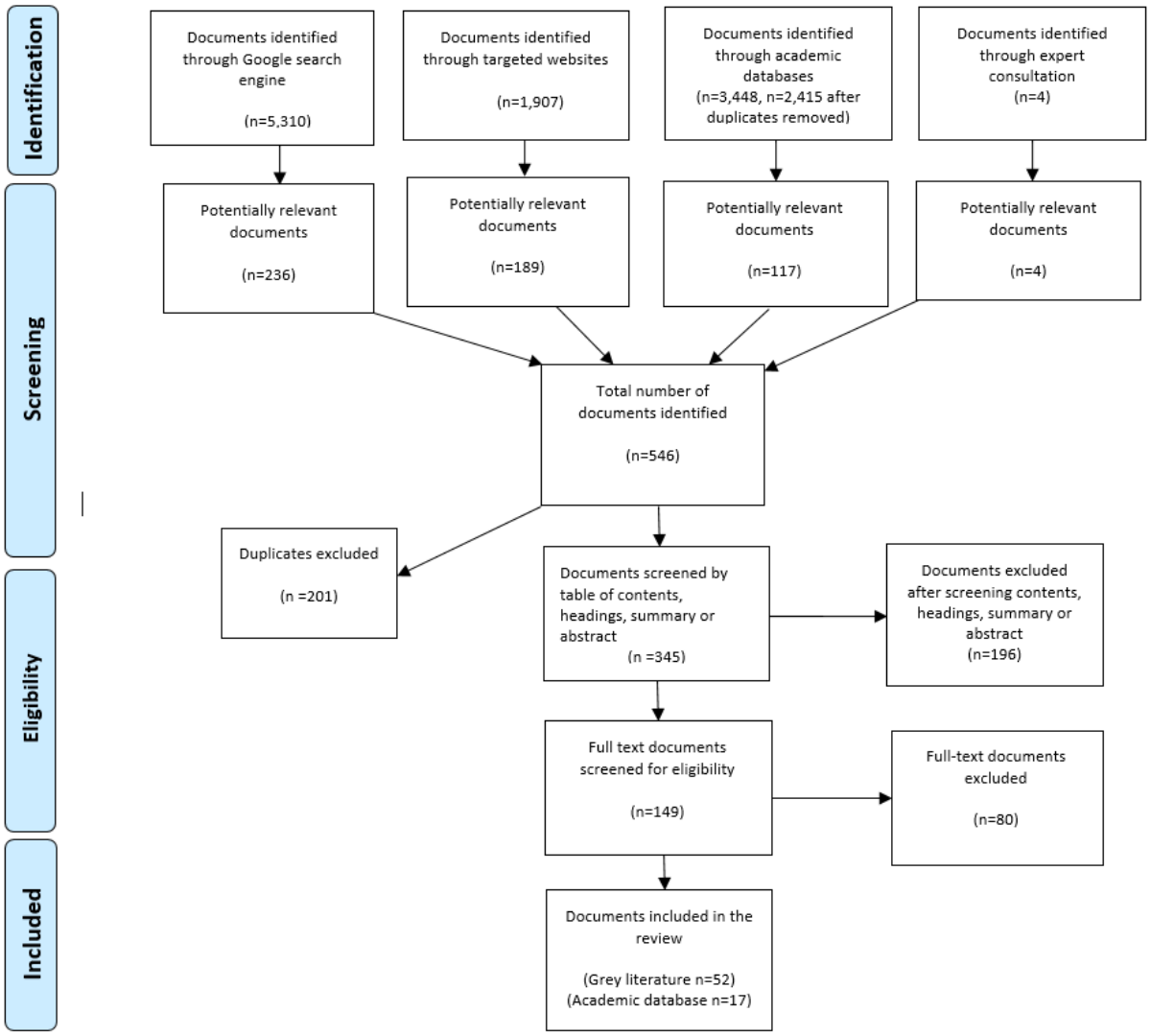

Figure 8.1: PRISMA Flow Diagram

Data collection process and synthesis of results

Following basic demographic information about manuscript, date, title, author and sources, data extraction was structured around the two research questions, and included: characteristics of general health system funding, pooling and purchasing; maternal health service models; maternal health-specific examples of funding, pooling and purchasing in Australia; current services costs; and identifiable trends. Categories were used to produce descriptive and subsequently analytical summaries that were refined through several phases of discussion and writing among all authors. Documents that did not address (either explicitly or inexplicitly) the funding, pooling or purchasing of maternal health services in Australia were excluded at this stage. Those that did, were then extracted into the data extraction tool.

Results

We present the results in three sections. First, given the absence of such in either peer-review of grey literature to-date, we briefly summarise the funding, pooling and purchasing mechanisms in the Australian health system at-large. Second, we describe the models of maternity care in Australia and their relationship to the funding, pooling and purchasing mechanisms. Third, we reflect on three emerging trends in maternal health care that appear to be linked to financing mechanisms, as synthesised from the literature.

Section 1: Financing Mechanisms in the Australian Health System.

Funding

Government funding

Healthcare funding mechanisms in Australia are complex and determined by government and non-government sectors. Government sectors include the Federal[22], state and territory governments, and in some jurisdictions, local governments. The non-government sectors primarily include individuals, private health insurers, third-party motor vehicle insurers, workers compensation and funding for research from non-Government organisations (365). The below figure provides an illustration of the funding sources and relationships and the types of products that are financed.

[22] The Government of the Commonwealth of Australia (also referred to as the Australian Government, the Commonwealth Government, or the Federal Government) operates under the Australian Constitution, which defines how the government can pass laws (25).

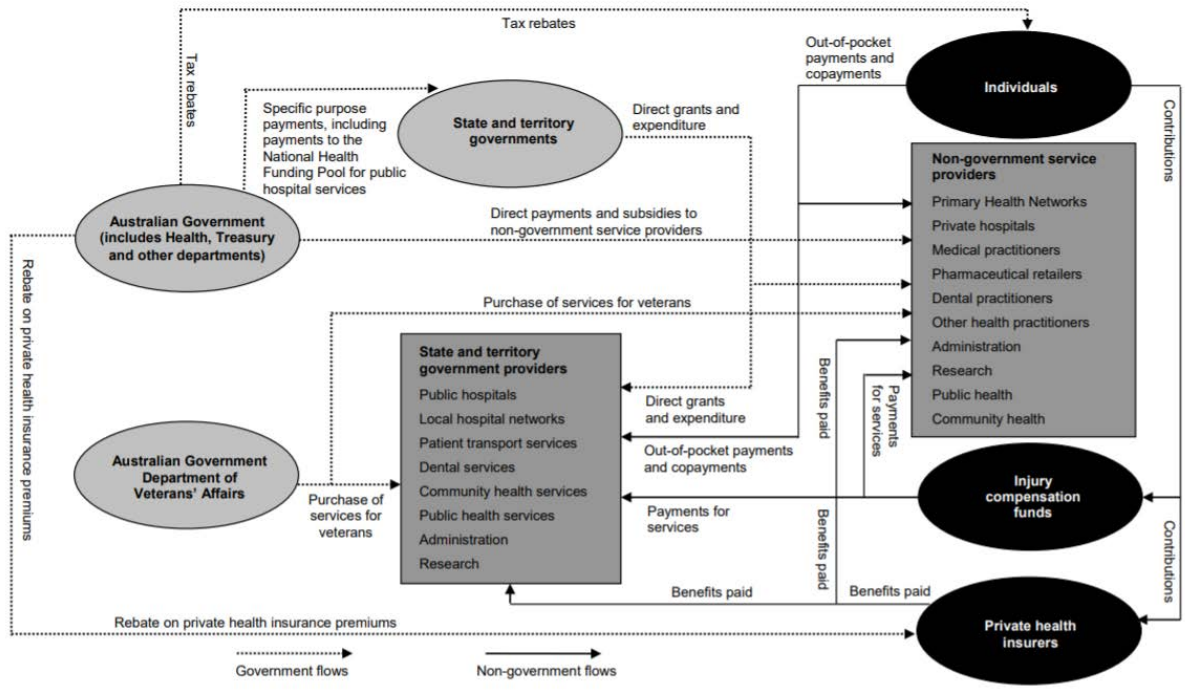

Figure 8.2: Funding sources and relationships of Australia's health system. Source: The Australian Institute of Health and Welfare (365).

The *National Health Reform Agreement*, which sets out Australia's health care funding rules, was established in 2011 between states, territories and the Federal government to guide an effective partnership for funding, pooling and purchasing health care goods and services. The aim of the agreement was to establish shared incentives for all levels of government to make better use of resources (366, 367). The agreement recognises that the states and territories are the system managers of public hospitals and the Federal Government has full funding and program responsibility for General Practitioner (GP) services, and primary health care. The health financing arrangements of the agreement include block funding and Activity Based Funding (ABF). Block funding is a Federal Government funding system for public hospitals whereby a fixed amount is provided to public hospitals based on population size and the previous year of funding. ABF is a way of funding hospitals where the hospitals get paid based solely on the number, mix, and case mix of patients they treat. If a hospital treats more patients, they receive more funding (368). However, under the current ABF arrangements, the Federal Government will not increase payments to each state and territory by more than 6.5% limiting the potential for hospitals to increase revenue by increasing case-load by that amount (369).

All levels of government source funds to finance the health care system from various types of taxes and levies (365). The Federal Government is the major tax collector (raising 81% of Australia's total tax funds), and it divides the funds among the lower levels of government with 50% going to the

state and territory and local governments. Funding is also received by non-tax revenues such as minerals, gas, and petroleum, which can be allocated to health (370). The funds from taxation and non-tax revenue are then used by the Federal Government to pay for block funding and ABF towards the states and territories by depositing the funds into the National Health Funding Pool (371).

Levies are an additional charge that can be collected by any level of government to fund health care (372). The Federal Government has imposed several levies to collect funds to finance Medicare, including the 'Medicare Levy' and the 'Medicare Levy Surcharge' (373). The Medicare Levy is currently set at 2% of taxable income on individuals that earn above A$21,655 per annum (374), making it a 'flat tax' as both high-and-low income earners are contributing the same portion of their income (375). The Medicare Levy Surcharge imposes a further 1-1.5% on high-income earners who do not have private health insurance and earn above A$90,000 per annum for singles and A$180,000 per annum for families (373). The purpose of the Medicare Levy Surcharge was to encourage people to uptake private health insurance and reduce the burden on the public health system (373).

Non-government funding

Out-of-pocket costs incurred by individuals made up A$24.4 billion out of the total A$140.2 billion spent on health care in 2011-12, which is more than double the A$11 billion spent in the previous decade. The proportion of total health expenditure funded by individual out-of-pocket costs during this time remained relatively unchanged (17.5% in 2002 and 17.3% in 2012) (376). Private health insurance¸ which is held by 57.1% of Australians aged 18 years and over (377), produces two costs; insurance premiums and out-of-pocket costs to cover medical treatment that is not covered by either Medicare or the private health insurer. 'Gap payments', which are payments made by the individual for either hospital or medical charges that are greater than what the private health insurer pays, vary between different private health insurers, with the average gap payment for in-hospital treatment being A$316 (March 2019) (323).

Pooling

Funding from both Government and non-Government sources are pooled separately. Expenditure by the Federal Government Department of Health, Medicare and the Pharmaceutical Benefits Scheme come from general revenue. Levies are paid into general revenue and are not hypothecated to health. Non-Government resources of health expenditure are paid to health providers either through Private Health Insurance or out-of-pocket payments.

Inter-Governmental Pooling

Funding that is pooled into the National Health Funding Pool is managed by an Administrator who is distinct from any level of government. They are responsible for ensuring that funds are deposited and administered as per the National Health Reform Agreement and for overseeing payments into and out of the pool account for each state and territory (378). Maximising the system's capacity to redistribute resources is central to achieving the goals of financial protection and equity in service use; in this way, service use can be driven by health needs, rather than an ability to pay.

Government-Private-Sector Pooling

Pooling in the private sector is achieved via Government-subsidized premiums. The 'Australian Government Private Health Insurance Rebate' is an income-tested rebate that the Australian Government provides people to help cover the cost of their private health insurance premiums. The percentage that is rebated is anywhere from 0% for those who earn greater than A$140,001 per single or $280,001 per family, up to 38% for those on lower incomes (379). The Lifetime Health Cover Private Health Insurance was introduced with the objective of increasing the uptake of hospital insurance earlier in life. The Lifetime Health Cover enforces penalties in the form of premium loadings if the health insurance is not purchased by the age of 31 (324). This policy, introduced in 2001 has been shown to be a key driver of the current increase in the percentage of people with private health insurance in Australia (380).

Voluntary health insurance should spread risk and make access more affordable. However, insurance premiums, even where subsidised, remain a key barrier to uptake of such insurance for those in lower-income brackets. In Australia, for example, those with private health insurance are made up of wealthier (381), urban (382), non-Aboriginal or Torres Strait Islander (383) people. Therefore, pooling money into voluntary health insurance schemes such as private health may not maximise the redistributive capacity of public revenues.

Purchasing

Private Hospitals

Australia has a total of 1,359 public and private hospitals (747 and 612 respectively) (325). Private hospitals are owned and operated by the private sector, however, they are licensed and regulated by governments. Hospitals in the private sector consist of not-for-profits and for-profits, with different incentives and therefore, different market behaviours. The Private Health Insurance industry is highly concentrated with only 5 funds accounting for more than 80% of all policies, with almost 70% of the industry now operating on a for-profit basis (325).

Public Hospitals

Purchasing public health services in Australia involves both levels of government, creating a complex set of overlapping and fragmented responsibilities (384). Each state and territory has its own government and holds responsibility for public hospital care and community health services within its jurisdiction. Money is received by the states and territories via the National Health Funding Pool and then each state and territory decides how to spend their money on purchasing health services. The states and territories operate public hospitals, however, funding them is a joint responsibility of both Federal and state governments. The Federal government is solely responsible for purchasing benefits through Medicare for health services such as out-of-hospital medical care and in-hospital private medical care, and for the Pharmaceutical Benefits Scheme (see below) (384). Medicare itself does not deliver healthcare but rather it purchases healthcare services for those covered by the scheme, which allows for free treatment for public patients in public hospitals and subsidises private patients in public hospitals (75% of the schedule fee). Federal and state and territory governments also responsible for funding and delivering health and medical research, Aboriginal and Torres Strait Islander specific health services, public health initiatives, and community health services. Local governments provide community-based health services alongside contributing to public health and health promotion initiatives, such as child and maternal health services (385).

Pharmaceuticals Benefits Scheme

Medicines are subsidised by the Federal government under the Pharmaceuticals Benefits Scheme (PBS) (325). The PBS schedule lists all of the medicines that can be administered to all Australian residents that hold a Medicare card at a government-subsidised price (386). Under the PBS, the cost incurred by the patient varies, depending on the difference between the schedule fee and the actual cost of the medication with a maximum payment of A$38.30 for general patients and A$6.20 for people with a concession card (387). Safety net thresholds exist to reduce the financial burden for those that require a substantial amount of medications. The safety net threshold is A$378.00 per annum for concession card holders and A$1,494.90 for all other patients. After reaching the safety net threshold general patients pay for any further PBS prescriptions at the concessional payment rate and concession card holders face no further charges for medications for the remainder of the calendar year (386). If a medication is not listed on the PBS schedule, the patient has to pay the full price for the prescription (388). Pharmaceuticals for public patients in public hospitals are typically provided for free (325). However, Australians pay almost four times more than the best international prices for a range of out of hospital prescription medicines, with 6% of patients delaying or forgoing necessary medication due to cost (389).

Primary health care

General Practitioners (GPs) are considered the primary point of medical care and the gatekeeper to the rest of the health system as all specialist care requires a GP referral. Medicare purchases out-of-hospital medical services and therefore provides some benefits under the Medicare Benefits Schedule (MBS) for services such as consultations with medical specialists and general practitioners (80% or 100% of the schedule fee). Under the MBS, patients will receive a 'rebate', which is based upon a proportion of the schedule fee covering each type of service. For example, when a woman receives a pathology test to confirm pregnancy it has a schedule fee of A$10.15 and the benefit of the fee is 75% or A$7.65 (352). There are three potential fee options for a GP consultation: the doctor bulk bills the patient and Medicare rebates 100% of the Schedule fee leaving the patient with no out-of-pocket costs; the doctor bulk bills the patient but the fees charged for the service are greater than the Medicare Schedule fee leaving the patient with a 'gap fee'; or the doctor does not bulk bill and the patient is left to cover the entire consultation fee (390). The decision to bulk bill a patient is at the discretion of the doctor. If a doctor decides to bulk bill it means their payment for the service provided will be either 85 or 100 percent (depending on the type of service provided) of the Medicare Schedule fee. Greater than 80% of all GP consultations are paid for via bulk billing arrangements under Medicare, however, many doctors charge above the schedule fee leaving patients with a 'gap fee', whereby the doctor receives a payment from both Medicare and the patient (391). GPs primarily work in private practices, where they receive a fee for service payment (390).

As part of Medicare, the 'Original Medicare Safety Net' (OMSN) was introduced with the aim to provide a 100% financial rebate to individuals accessing out-of-hospital services once an annual threshold is met. The Extended Medicare Safety Net (EMSN), which works in conjunction with the OMSN, also forms part of Medicare with the aim to provide a higher Medicare benefit for out-of-hospital health care costs for people with ongoing health needs. Once the annual threshold of out-of-pocket costs has been met, Medicare will pay for 80% of any future out-of-pocket costs for out-of-hospital Medicare services for the remainder of the calendar year. Due to unregulated provider fees in Australia (380), private providers can charge well above the schedule fee. Even with the 80% EMSN fee coverage, high fees charged by private providers mean that individuals may be left with a significant difference to cover as an out-of-pocket cost (392).

Section 2: Models of maternity care in Australia

As with health care generally, the arrangements underpinning maternity services in Australia are complex and achieved through a mix of Federal, state and territory and private funding and delivery

via state and territory government providers' and Non-government service providers (Figure 8.2). The Federal Government funds maternal services through the MBS and PBS, state governments through the National Healthcare Agreement, private health insurance via the private health insurance rebate and through other specifically targeted programs including Indigenous maternal and child health programs (393). Limited information is available on the costs of providing maternity care in Australia, which restricts the ability to revise maternity service funding (97). The AIHW reported that the total expenditure on maternity care in 2004-05 was $1,672 million. Of this, $1,538 million was spent on hospital-admitted services associated with deliveries taking place in a hospital and $134 million was spent on neonatal care (394). State and territory and local governments fund and deliver a range of *community* health services (such as antenatal and postnatal parenting support, breastfeeding programs, immunisation services, and health promotion programs targeted at women during the perinatal period). However, a comprehensive national picture of community health services is not available due to a lack of statistical information being collected (325).

Maternal health care in Australia includes antenatal, intrapartum, and postnatal care for mothers and babies up to six weeks after birth (395). A review of Australia's maternity services (2010) (97) found that women were dissatisfied with the current system and the choices that were or were not available to them. Many women who took part in the review indicated a preference to receive care from midwives. In Australia, a range of different models of maternity care are available (326, 396-398) (Table 8.2). The availability of maternity care models within the public and private system and the characteristics of the model can differ between states, between levels of rurality and between individual health services.

Ninety-three percent of mothers receive care through one of four models; **private** obstetric care (31.8%); **combined** maternity care (24.3%); **public hospital** maternity care (22.4%), and **shared maternity** care (14.2%) (97). Less commonly accessed models include private midwifery care, and team and caseload midwifery care.

Table 8.2: The major Model Categories from the Maternity Care Classification System (396). Source: University of New South Wales and Australian Institute of Health and Welfare.

Model of care	**Characteristics**
Private obstetrician	Antenatal care provided by a private specialist obstetrician. Intrapartum care is provided in either a private or public hospital by the private specialist obstetrician and hospital midwives in collaboration. Postnatal care is usually provided in the

(specialist) care	hospital by the private specialist obstetrician and hospital midwives and may continue in the home, hotel or hostel.
Private midwifery care	Antenatal, intrapartum and postnatal care is provided by a private midwife or group of midwives in collaboration with doctors in the event of identified risk factors. Antenatal, intrapartum and postnatal care could be provided in a range of locations including the home.
General Practitioner obstetrician care	Antenatal care provided by a GP obstetrician. Intrapartum care is provided in either a private or public hospital by the GP obstetrician and hospital midwives in collaboration. Postnatal care is usually provided in the hospital by the GP obstetrician and hospital midwives and may continue in the home or community.
Public hospital maternity care	Antenatal care is provided in hospital outpatient clinics (either onsite or outreach) by midwives and/or doctors. Care could also be provided by a multidisciplinary team. Intrapartum and postnatal care is provided in the hospital by midwives and doctors in collaboration. Postnatal care may continue in the home or community by hospital midwives.
Public hospital high-risk maternity	Antenatal care is provided to women with medical high-risk/complex pregnancies by maternity care providers (specialist obstetricians and/or maternal-fetal medicine subspecialists in collaboration with midwives) with an interest in high-risk maternity care in a public hospital. Intrapartum and postnatal care is provided by hospital doctors and midwives. Postnatal care may continue in the home or community by hospital midwives.
Shared care	Antenatal care is provided by a community maternity service provider (doctor and/or midwife) in collaboration with public hospital doctors and midwives under an established agreement and can occur both in the community and in hospital outpatient clinics. Intrapartum and early postnatal care usually takes place in a public hospital by hospital midwives and doctors often in conjunction with the community doctor or midwife (particularly in rural settings).
Combined care	Antenatal care is provided by a community maternity service provider (doctor and/or midwife) in the community. Intrapartum and early postnatal care are provided in the public hospital by hospital midwives and doctors.

Team midwifery care	Antenatal, intrapartum and postnatal care is provided by a small team of rostered midwives (no more than eight) in collaboration with doctors in the event of identified risk factors. Intrapartum care is usually provided in a public hospital or birth centre. Postnatal care may continue in the home or community by the team midwives.
Midwifery Group Practice caseload care	Antenatal, intrapartum and postnatal care is provided within a publicly-funded caseload model by a known primary midwife with secondary backup midwife/midwives providing cover and assistance with collaboration with doctors in the event of identified risk factors. Antenatal care and postnatal care is usually provided in a public hospital, community or home with intrapartum care in a hospital, birth centre or home.
Remote area maternity care	Antenatal and postnatal care is provided in remote communities by a remote area midwife (or a remote area nurse) or group of midwives sometimes in collaboration with a remote area nurse and/or doctor. Antenatal care may also be provided via telehealth or fly-in-fly-out clinicians in an outreach setting. Intrapartum and early postnatal care is provided in a regional or metropolitan hospital (involving temporary relocation prior to labour) by hospital midwives and doctors.
Private obstetrician and privately practicing midwife joint care	Antenatal, intrapartum and postnatal care is provided by a privately practicing obstetrician and midwife from the same collaborative private practice. Intrapartum care is usually provided in either a private or public hospital by the privately practicing midwife and/or private specialist obstetrician in collaboration with hospital midwifery staff. Postnatal care is usually provided in the hospital and may continue in the home, hotel or hostel by the privately practicing midwife.

Note: 'Doctors' include specialist obstetricians, GP obstetricians and obstetricians in training.

Pregnant women who are screened as having a 'low risk' pregnancy and want to receive care as a **public** patient usually receive advice from their GP to book in at their closest hospital that has maternity services available. In public hospital care, it is unlikely that mothers will receive the same doctor or midwife at each antenatal check-up. Additionally, the doctors and midwives that attend the antenatal appointments are not likely to be the practitioners that attend the birth. As a public

patient, mothers do not have a choice of practitioner but fees and expenses are typically low or provided for free if the mother holds a Medicare card (399).

If a woman is considered a 'low risk' pregnancy and she can access a public health service that provides either **shared** or **combined** care, she can elect to receive one of these models of care (326). In **shared and combined** care the public hospital receives funding for each inpatient hospital event through either ABF or block funding and the doctor receives funding for each occasion of service delivered through the MBS and from the mother for any gap payments. The doctor can also charge a once-off management fee under the MBS, with the woman again liable for any gap payments. Mothers who access the shared or combined models of care may incur some out-of-pocket fees as doctors and midwives may impose these costs and the amount charged can vary. Although Medicare provides rebates to mothers to cover a portion of the cost of care when they access non-public services, medical provider fees are unregulated (380), leaving patients to pay the "out-of-pocket" cost difference between the providers' fee and the Medicare rebate (400). The majority of out-of-pocket costs that mothers incur for maternity services are related to specialist medical services (e.g. obstetric services) (97), as only a small portion of such services are bulk billed[23] (376).

If a woman can afford to, she can also choose to receive wholly **private** obstetric care. The private obstetric model of care allows for choice of obstetrician and typically has shorter appointment waiting times. However, due to the cost of private health insurance and not all medical items being covered by the insurer (such as out of hospital costs) doing so can be quite expensive. In this model of care, the private obstetrician will receive fees for his/her service via the MBS and from the woman for any gap payments (240). Most OECD countries have abandoned this way of spending public funds due to the rising costs associated with private health and the inequities caused by having a 'two-tiered' health system (401). Australians continue to experience the repercussion of Private

[23] When the provider bills Medicare directly and accepts the Medicare benefit as full payment for their service and the individual does not have any out-of-pocket costs as a result of that appointment.

Health Insurance reforms, with only those who can afford private health insurance receiving more timely access to health care services (376, 381).

Continuity of care, whereby a woman receives perinatal care by the same midwife or team of midwives, is considered 'gold standard' for mothers during pregnancy and childbirth as it is known to improve birth outcomes for both the mother and baby (238, 239). In Australia, Midwifery Group Practice caseload care is the model of care that is most aligned with continuity of care. The level of continuity varies both between and within other different models of care, due to variations in the characteristics of models of care between individual health services (402). Women may access continuity of midwifery care in Australia by either being allocated to official models of maternity care whereby women receive continuous care from a midwife or a team of midwives – 'Midwifery Group Practice Caseload Care' and 'Team Midwifery Care' in a public hospital or by engaging a private midwife to provide care, and still giving birth in a public hospital. The terms "continuity model" or "continuity model of care", although not the official terms for models of care, they are terms that are commonly used in maternity care, particularly in the midwifery field (403). In a public midwife continuity model, the public hospital receives funding for each hospital inpatient event through either ABF or block funding; with the private midwife model, the public hospital still receives funding for each inpatient event, but the private midwife will also receive funding through the MBS, and from the woman for any gap payments.

Section 3: Trends in financing and maternity care in Australia

In reviewing the financing of the various maternity models outlined above, we identified three trends. First, a trend towards privatisation of maternity care; second increasing medicalisation of birth; and third, a concurrent limiting of Australian mothers' choice to access midwifery care. All three trends are likely to have contributed to the rising costs of maternal healthcare to both individuals and the health system.

Privatisation and Rising Costs of Maternity Care

Currently, 26% of mothers who give birth in Australian hospitals do so in a private hospital under the care of a private obstetrician and are thus liable for some type of gap payment (113). The evidence reviewed in this study suggests that pooling funds through private health care providers has weakened the efficiency of the publically funded health system by facilitating market-driven price-setting among private health care providers and insurance companies. Following the introduction of the EMSN, there was a substantial rise in consultation fees charged by privately practicing obstetricians for antenatal attendances (395), with out of pocket charges for obstetric services delivered outside hospitals rising by 1,035% between 1992 and 2016, even after adjusting for

inflation (90). The costs to individuals of this trend are substantial as fees incurred out of hospital are not covered by private health insurance. Even for in-hospital out of pocket fees, where private health insurance may pay for some or all of the gap (323), women may be left vulnerable to large out of pocket fees if their private health insurance does not cover the full amount (404). For example, although the government schedule fee for an obstetrician consultation in Australia is A$85.55 (392), the *average* (unregulated) fee being charged for an in-hospital obstetrician consultation in Australia in 2017 was A$781.07 (90). Since the benefit that mothers may claim for this service is calculated as 75% of the government *scheduled* fee (i.e. $64.20) the average gap payment (which is the previously mentioned *total average* $781. 07 fee for the consultation minus the $64.20, which is 75% of the government *scheduled* fee) for mothers attending a single private obstetrician consultation in Australia is $716.87 (405). A frequently articulated concern regarding private health insurance is the lack of disclosure about the total out-of-pocket costs that will be incurred, with individuals being left with high and unexpected out-of-pocket costs (406). In response to such complaints, a key private health insurer is trialing a no-gap fee pregnancy program (407). However, a lack of transparency, inadequate informed financial consent, and uncertainty around whose responsibility financial consent is (between the physician or private health insurer), are recurring complaints by individuals left with high out-of-pocket costs on top of their private health insurance premiums (380, 408).

The costs to the health system are similarly large, with care for reproductive and maternal health costing $7,711,415, 988 (2015-2016) (409). Between 2003 and 2008, the amount of Federal Government MBS funding for obstetric services climbed 174% from $77 million to $211 million. During the same time period, the number of babies born only increased by 17% from 256,925 to 296,925 (50, 410). The increased charges associated with providing obstetric care has been absorbed by public funds with a considerable portion of total MBS funding for obstetric services channelled through the EMSN (97). Of that $134 million increase, approximately $130 million was due to MBS item 16590, for the 'Planning and Management of Pregnancy', which was claimed for services provided by privately practicing obstetricians (97). EMSN payments for obstetric services made up for 31% of total safety net expenditures on all healthcare in 2008 (97) and were paradoxically shown to be larger in areas with high median family income and lower overall health care needs (411).

While public hospitals are managed by state and territory governments, most out of hospital services are delivered by private providers (325). Therefore, in a private obstetrician-led care model, the private obstetrician will receive funding through the MBS for any services delivered, as well as from the woman for any gap payments. There are a number of MBS items that cover post-partum

pregnancy care mainly catering to mothers who need medical complications addressed immediately after birth (412).

Medicalisation of childbirth

The introduction of Private Health Insurance Incentives Scheme was associated with a decrease in public birth rates and an increase in private birth rates (413). Simultaneously, there has been an increase in use of medical tests and procedures (for example, episiotomies, epidural, induction of labour, forceps and vacuum extraction) within perinatal care (414, 415), as obstetric involvement, and the use of medical interventions during pregnancy and childbirth have become routine even in low-risk pregnancies (416). Australia has also seen a decrease in vaginal deliveries from 51.9% in 2004 to 47.1% in 2013, an increase in caesarean sections both in the public and private sector (417). Caesarean sections for women giving birth for the first time in Australia have increased from 31.7% to 38.2% in the private sector and 20.4% to 25.8% in the public sector between 2000 and 2015 (114). This is despite private sector clients generally coming from ethnic, socio-economic and geographic backgrounds with lower rates of maternity-related risk factors that would indicate the need for medical intervention (413, 418). Caesarean sections are not only more costly than a vaginal delivery ($9,603 per caesarean delivery with minor complications, compared with $4,211 for a vaginal delivery with minor complications, 2014-15) (419), but they are associated with an increased likelihood that the mother or baby will experience poorer birth outcomes, and increased likelihood that the mother will require a repeat caesarean section for a subsequent birth (51, 123), producing further costs to both individuals and the healthcare system (416).

Although increased medicalisation of childbirth has seen a significant rise in the cost of obstetric services in Australia (11), the full costs are unknown. Unlike some countries (420-422), Australia currently does not monitor the costs associated with the “burden of disease” resulting from maternal health system performance, such as the short-and-long-term costs associated with high rates of obstetric interventions.

Women’s Choice to access midwifery care

Women who receive midwifery continuity of care models are less likely to have an instrumental birth and more likely to experience a normal vaginal birth (238, 239, 423). Furthermore, the evidence suggests that for women who receive this model of care, enhanced patient satisfaction during pregnancy and childbirth, with the feelings of greater preparedness for birth and parenting, alongside reduced health care costs being experienced (238). In 2009, it was suggested an extension

of Australia's Federal Government funding to midwives as primary maternity care providers who are crucial to improving access to evidence-based maternal health care (97). Despite this, Medicare funding for midwifery services (first introduced in 2006) is still only provided to eligible privately practicing midwives working in collaboration with a specified medical practitioner (424) and in specifically prescribed circumstances such as in remote settings where no obstetrician is available (97). Australian women may access midwifery care through public hospitals and birthing centres, but the supply does not meet the current levels of demand with public hospitals in many locations not offering, or only offering limited access to this model of care (97). Where women wish to have guaranteed access to continuity of midwifery care, they must, therefore, access it privately and cover the associated out-of-pocket costs without rebate. The limited role of midwives has been found to have consequential restrictions on women's choice of care during the perinatal period (97).

Discussion

This study fills an important gap in the literature by characterising the current health financing mechanisms in Australia and highlighting some concerns relating to their impact on maternal health care. The main concerns identified include increased privatisation and associated rising costs to the system and to individuals; increased medicalisation of birth; and limited access to gold-standard midwifery continuity of care.

The study results demonstrate the dominant combination of ABF and fee-for-service funding models can create an incentive for delivering 'volume' of maternal care, rather than the quality of care since a hospital or individual provider is financially rewarded for every occasion of care (400, 405). The more occasions of care, the more money is received by service providers or institutions, regardless of the outcomes for the mother. This incentive exists in both the public and private system, although in the private system and for out-of-hospital services the incentive may be larger since fees are unregulated (425), and providers operate on a for-profit basis.

Our results also suggest that ABF and fee-for-service funding models combined with government advocacy for private health insurance could be indirectly contributing to a trend of increasing medicalisation of childbirth. Government reforms that have advocated for the uptake of private health insurance (324), and concurrent pooling of public funds to subsidise private healthcare (379), have encouraged many Australian women to seek private care through a private provider, which have demonstrated higher rates of obstetric interventions. Medical intervention in childbirth attracts a higher payment from the government via ABF in the public system or, in the private system a high payment from some combination of the insurer and client (fee for service).

Lastly, our results indicate that despite midwifery continuity of care models costing less, and having better outcomes for both mothers and their babies (238, 239), the current financing mechanisms actively restrict access to this option. Models of care that encompass midwifery continuity of care characteristics are available in public hospitals, but demand easily outstrips supply (97). Continuity of care from a midwife or team of midwives is only otherwise available under a private model of maternity care – including paying a midwife – and incurring substantial out of pocket costs, making it inaccessible to many (97). The current financing mechanisms contribute to this effective restriction on affordable continuity of midwifery care, by directing a large proportion of public maternal health resources into private funding (through MBS subsidies to private obstetricians) (97) and pooling (through the Private Health Insurance Incentive Scheme) (324, 379) of maternal health care. In health systems in other countries such as New Zealand (426), Canada (427), the Netherlands (420), and Britain (421), health financing policy directs funding towards primary health providers such as midwives in community-based services.

Limitations

This study was based exclusively on document review. It represents our best attempt to interpret current trends and the influence of financing mechanisms on them. However, questions relating to the exact manner and combination in which financing mechanisms are influencing policy and organisation decisions regarding maternity care in all geographical settings in Australia remain and should be the focus of further study. In addition, this review included documents from think tanks, politicians and position statements with views influenced by individual and institutional agendas.

Conclusion

In summary, there is currently an unequal distribution of maternal health care resources among population groups with those who are financially, ethnically and geographically marginalised experiencing the greatest disadvantages. A combination of Federal policy reforms and unregulated medical fees allows for increasing privatisation and cost-shifting onto mothers who access the healthcare system, with growing costs taking place at both an individual and system level. Financing mechanisms that incentivise volume as opposed to quality of care can mean health services and care providers are not motivated to deliver woman-centred health outcomes.

Although midwifery continuity of care models are more cost-effective and have been demonstrated to produce better health outcomes for both mother and baby, the current financing arrangements leave mothers with limited choice over the type of care they receive. These financing arrangements are inefficient and could be contributing to the increasing medicalisation of maternity care. Specific

research is needed to better understand the influence of financial, institutional and political levers shaping the delivery and uptake of different maternity models in 21st century Australia.

Section 5: Discussion and conclusion

Section 1: Introduction and methods

Chapter one: Introduction

Chapter two: Methods

Section 2: Inequities in maternal health service provision

Chapter three: Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers

Fox H, Callander E, Lindsay D, Topp S. Evidence of overuse? Patterns of obstetric interventions during labour and birth among Australian mothers. *BMC Pregnancy and Childbirth*. 2019;19(1):226. DOI: https://doi.org/10.1186/s12884-019-2369-5

Chapter four: Ethnic, socioeconomic and geographic inequities in maternal health service coverage in Australia.

Fox H, Topp S, Lindsay D, Callander E. Racial, socioeconomic and geographic inequities in maternal health service coverage in Australia. *International Journal of Health Planning and management*. Under review. 2021.

Chapter five: Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals.

Fox H, Callander E, Lindsay D, Topp S. Is there unwarranted variation in obstetric practice in Australia? Obstetric intervention trends in Australian hospitals. *Australian Health Review*.2021; DOI: https://doi.org/10.1071/AH20014

Research question 1

Section 3: A case study of the determinants of caesarean section provision in Queensland hospitals.

Chapter six: A cascade of interventions: determinants of caesarean sections in Australian public hospitals.

Fox H, Topp S, Lindsay D, Callander E. A cascade of interventions: determinants of caesarean sections in Australian public hospitals. *Birth.* 2021. DOI: https://doi.org/10.1111/birt.12530

Chapter seven: Drivers of primary caesarean sections in Australian private hospitals..

Fox H, Topp S, Lindsay D, Callander E. Determinants of caesarean sections in Australian private hospitals. *Midwifery*. Under review. 2021.

Research question 2

Section 4: Macro-level healthcare financing policy levers of maternal health care

Chapter eight: A review of the impact of financing mechanisms on maternal health care in Australia

Fox H, Topp SM, Callander E, Lindsay D. A review of the impact of financing mechanisms on maternal health care in Australia. BMC public health. 2019;19(1):1540. DOI: https://doi.org/10.1186/s12889-019-7850-6

Research question 3

Section 5: Discussion and conclusion

Chapter nine: Discussion and conclusion

Chapter 9: Discussion

The process used to develop the discussion section of the thesis involved critically reviewing both the academic and grey literature. This took place throughout the time period of Ph.D candidature (2017-2021), with key citations used throughout the discussion section to justify my position.

Overall, this thesis presents four major findings. Firstly, at the population level, variation in obstetric practice exists between hospital and health service jurisdictions and different population groups. This persisted after adjusting for maternal demographic and clinical characteristics, indicating that these factors do not explain this variation. The results of the thesis provides evidence of above optimal rates of caesarean sections in Queensland hospitals, which were particularly high in the private sector. Secondly, the provision of caesarean sections are being driven by a cascade of obstetric interventions in the public sector, and elective caesarean sections in the private sector. Thirdly, the findings have shown that specific population groups –non-First Nations, urban and higher socioeconomic women – are receiving a higher portion of costly medical and surgical obstetric interventions, whilst their First Nations, rural and remote and socioeconomically disadvantaged counterparts, who demonstrate greater healthcare needs, do not receive adequate health service coverage. The final major finding from this thesis is that macro-level health and financing policies are contributing to a pattern of inequitable maternal health care provision and coverage and an increasing medicalisation of childbirth.

Variation in obstetric practice and above optimal use of caesarean sections in Queensland hospitals

The findings from this thesis have demonstrated that variation in obstetric practice exists between Hospital and Health Service jurisdictions and different population groups, which remained after adjustment for maternal risk factors and clinical characteristics. Further, the provision of caesarean sections in both public and private hospitals were found to not be majorly driven by the clinical needs of women. These findings suggest that non-clinical factors potentially at the patient, health provider, health service, and health system level may be contributing to the variation and potential overuse of obstetric interventions.

The variation observed in obstetric practice between hospital and health services may somewhat be attributable to differences in Clinical Practice Guidelines (CPGs) and the interpretation of evidence between hospitals and health providers and differences in hospital or health provider culture and practices rather than the individual needs of women (428, 429). Some examples of situations during labour and birth whereby these differences may lead to contrasting approaches to clinical management include vaginal birth after caesarean section, management of breech deliveries,

management of twin pregnancies, water immersion during labour and birth, continuous fetal monitoring, routine induction of labour over a certain gestational age, the progress of labour going outside of specific parameters, the duration of pushing, and cervical dilation (334, 429-433). One Australian study (431) that compared the CPGs for water immersion during labour and or birth between 25 hospitals found that inconsistencies existed in the documents regarding the criteria that would make a woman unsuitable for water immersion during labour and or birth. If a woman does not meet the criteria for water immersion during labour or birth, then a common alternative for pain relief is an epidural. Having a water birth compared to a conventional birth reduces the likelihood of women having other obstetric interventions such as a caesarean section (434). Whereas, having an epidural can lead to an increased likelihood of receiving other obstetric interventions (435).

Further, women who give birth in hospitals are under constant surveillance from medical and midwifery staff and can often be placed within time constraints and institutional parameters to maintain the safety and efficiency of the institution, rather than working within the woman's flow of labour and birth, which can lead to unwarranted obstetric intervention (428, 429). An example of the constant surveillance that women receive in hospitals during labour and birth is outlined in the Queensland Health *Normal Birth* guidelines (2017) (226). For women who are considered to be 'low-risk', that is, those who experience spontaneous labour at term with the baby in the vertex position should receive the following surveillance and risk assessment:

- After every contraction: assess fetal heart rate
- Every 15-30 minutes during active labour: check pulse and respiratory rate
- Every 30 minutes to 1 hour during active labour: check maternal temperature
- Continuous monitoring: urinary output
- Every 4 hours: check blood pressure
- Every 4 hours during labour: offer vaginal examination

Undoubtedly, it is essential to ensure the safety of both the woman and her baby and there needs to be ways to identify when labour is not progressing normally for each woman. However, labour and births that are managed within a hospital are measured by 'clock time' as opposed to letting women labour within their own time. An example of the time constraints placed upon women giving birth in Queensland hospitals is outlined in the Queensland Health *Normal Birth* guidelines. The guidelines suggest that there should be 0.5cm of cervical dilation per hour during active labour and if the cervical dilation falls outside of these parameters then clinical interventions should be considered (226). Additionally, giving birth in a health facility can also mean that women are forced to labour and give birth at the pace of the 'institutional momentum' rather than the natural rhythms of their

labour (428). For example, there is documented evidence of the institutional push to move women through a labour ward to avoid having a full ward with no free beds (428). Although this is done to prevent understaffing and to provide bed space to allow for emergency admissions, it means that laboring women are expected to be in synch with the institution, whilst ignoring women's physiological requirements, which often then leads to an intervened birth to meet the institutional needs (428).

Australia's National Guidance on Collaborative Maternity Care (436), which was developed after the National Review of Maternity Services (88), defines woman-centred care as being 'focused on the woman's individual, unique needs, expectations and aspirations, rather than the needs of institutions or maternity service professionals'. The latest guidelines in the strategic directions for maternity services - *Woman-centred care: Strategic directions for Australian maternity services* – is entirely focused on woman-centred care (437). Despite over a decade of focus on ensuring that maternity services are woman-centred, women continue to feel disempowered when giving birth in hospitals (438, 439). Moreover, a reform agenda aimed at improving woman-centredness, has not produced targeted measurement and evaluation of whether reform goals have been achieved, alongside a tapering off of interest and focus.

In Queensland, there has been a lack of commitment at the Hospital and Health Service level to implement woman-centered services (440). Woman-centered care is an important principle to guide the maternal health care reform agenda. However, to ensure that all Queensland hospitals are accountable for achieving care that focuses on meeting the needs of women, implementation and evaluation of targeted and measurable outcomes are required. The reinvigoration of efforts to improve woman-centred care is needed, alongside independently commissioned implementation research to understand whether, what, and how the intended reform agenda of achieving woman-centred care is working. Moving forward, that evidence should be used to accompany new guidelines for maternal healthcare reform in Australia. Little contemporary population-level evidence exists on the actual preferences of women. Further research is also needed to obtain up-to-date information on Australian women's birth preferences. Additionally, a better understanding of hospital and practitioner level logistical and organisational factors within individual institutions is required to better understand the mediators and or barriers to reducing potentially avoidable obstetric interventions.

Maternal risk factors and clinical needs are not driving obstetric interventions in Queensland hospitals

The results in this thesis provide evidence that maternal risk factors and the clinical needs of women were not the major drivers of obstetric interventions in Queensland hospitals. This may be a reflection of the risk aversion culture that has become increasingly prevalent in institutionalised childbirth and/or other factors. Birthing services within the acute hospital setting are plagued with risk discourse (441, 442), which then guide the overarching goal of hospital birthing services (428). No universally accepted definition of risk exists (443) as it can entail different meanings for different individuals, groups, and cultures and is mostly influenced by perception and experience (444). The notion of risk, which dominates biomedical and lay discourses and practices related to childbirth in Australia (256), can be considered to be both subjective and objective (445). From a subjective perspective, it is associated with an imagined loss or gain to one. It can also be associated with perceived danger and/or harm (446, 447). From an objective perspective, risk is considered to be a quantifiable and calculable concept, which heavily relies on scientific data (443). The medical model of maternity care, which considers pregnancy and childbirth to be dangerous and risky (448), exemplifies the objective approach to risk. Risk assessment in maternity care, which seeks to reduce pregnancy- and childbirth-associated mortality and morbidity, might provide some benefits in providing appropriate care in high-risk situations. However, standardised risk assessment approaches can channel women into clinical pathways that might not be beneficial to the individual requirements of the women (217, 449) and can also lead to the introduction of unwarranted medical or surgical interventions (450). Placing women into standardised risk categories, which then determines their pathway of care, is potentially reflected in the findings of this thesis as maternal risk factors and clinical needs were not the major drivers of obstetric interventions.

Placing medicalised risk parameters onto all women, regardless of whether they are experiencing a high-risk pregnancy or not, is not a reliable safeguard against risk, as obstetric interventions themselves can increase the risk of adverse health outcomes for both women and babies (11). For example, in an ethnographic study of the use of epidurals in an Australian public hospital (428), it was found that the cultural emphasis on risk made it easier for a woman to have an epidural as opposed to being able to get into a bath to assist with labour pain (451), although the evidence suggests that are safe and beneficial to women (452-454), and epidurals come with some associated risks (308). Further, risk is an abstract and changeable concept whereby the power rests with whoever defines what is risky (443, 445).

The presence of risk orientated birth policies, which are imposed by individual Hospitals and Health Services and guided by government policy, has created an overarching model of risk, that enables

medical authority and control over birth, whilst often going against the best clinical evidence and the autonomy of birthing women. Complications can arise during pregnancy and birth. However, pregnancy and childbirth are typically a healthy experience for the majority of women. In Australia, consideration must be given to the influence of individual Hospital and Health Service practices and cultures and the dominant risk aversion culture within our maternity system (428) so we can move towards the intended reform direction of providing woman-centred care. Reducing the potentially unnecessary use of obstetric interventions on healthy women could reduce avoidable negative health outcomes associated with obstetric interventions (11); improve the efficiency of healthcare spending; divert funds towards vulnerable population groups who have unmet healthcare needs, and reduce individual out-of-pocket costs that might be associated with iatrogenic health outcomes and subsequent healthcare use.

The findings in this thesis showed that clinicians' main reason for providing a primary caesarean section to women in private hospitals was for non-clinically indicated elective caesarean section. Private obstetric care is associated with higher rates of interventions in low-risk pregnancies and poorer neonatal outcomes including preterm birth, neonatal resuscitation, an APGAR score <7 at 5 minutes compared to public hospital care (208), by comparison, midwifery continuity of care is associated with fewer interventions, better health outcomes, greater satisfaction with birth and reduced costs (301). There is limited empirical data on the maternal health care preferences of Australian women, which is a limitation of the current knowledge-base in this field. However, the data that does exist shows that Australian women are demanding greater access to public midwifery care (455), which has also been an objective of maternity care reform in Australia for over a decade (97). However, the delivery of maternal healthcare in Australia, which has been shaped by market-orientated health policy and funding mechanisms, and a push for biomedical, privatized maternity services, including fee-for-service models (456). Despite the evidence, there is also a continued push from professional medical bodies for maternity care to be controlled by privately practicing obstetricians (457).

If women and babies – who the system is intended to serve - are not benefiting from the current delivery of maternity services, this raises the question of who is benefiting from the dominant model of private obstetric care? One major example of the beneficiaries of the dominant model of private obstetric maternity care is the almost unlimited financial benefits that are received by privately practicing obstetricians via the MBS. Over a five-year period, there was a $134 million increase in Federal Government MBS funding for obstetric services, with 97% of this amount claimed for services provided by privately practicing obstetricians. This resulted in a 285% increase in the earnings of private specialist medical providers (458). The current macro-level health and financing

policies, perhaps unintentionally, are allowing for the commodification of pregnancy and childbirth to the benefit of privatized health markets, and not women and babies (459). The same policies are implicated in increasing rates of caesarean sections and inequities in access to services for vulnerable populations. Indeed, in light of some of the evidence presented in this thesis, it is questionable as to whether the provision of maternal health services under Australia's health system is responding to the best interests of women or the interests of privately practicing specialists. Ensuring women have access to a variety of models of care should be a priority, for women to be able to exercise choice in provider and style of care. Further, a better understanding of the power dynamics involved in the processes and decision-making of the current policies that shape maternity care in Australia is required to ensure that evidence-based woman-centred maternity care is available to all women.

Inequitable health service coverage and evidence of inequitable resource distribution

This thesis has demonstrated that the intention of Australia's health system to provide universal health care, nonetheless structurally discriminates against those who are already experiencing disadvantage within our society. That is, First Nations, rural and remote and socioeconomically disadvantaged women. One of the cornerstones of Australia's maternal healthcare reform has been to improve health equity for Australian women and babies. However, the findings from this thesis demonstrate that there are socioeconomic, geographic, and racially determined inequalities in the distribution of health resources and health services, alongside macro-level health and financing policies that favour certain population groups in terms of health resources and healthcare coverage. This is evidenced in several findings in this thesis. First, there is evidence of an unequal distribution of health resources via the potentially unnecessary overuse of costly medical and surgical obstetric interventions provided to non-First Nations, urban, and higher socioeconomic women. Second, the results also demonstrate a general pattern of reduced healthcare coverage of antenatal care, mental health care, and chronic healthcare services for First Nations, rural and remote, and socioeconomically disadvantaged women. These findings indicate that whether intentionally or not, both primary and tertiary healthcare resources favour non-First Nations women, women living in cities, and those who experience the least socioeconomic disadvantage.

Inequity in the distribution of health resources and services has the potential to exacerbate pre-existing disparities in health and quality of life, as reflected in the poorer maternal health outcomes experienced by First Nations, rural and remote, and socioeconomically disadvantaged women and babies in Australia (7). Having a universal health system should not allow for complacency or serve as a rationale for overlooking disadvantaged populations. As the results presented in this thesis have demonstrated, universal health coverage does not equate to equity, but rather the findings indicate

that it is the women who need health care the most are those who are receiving fewer healthcare resources and services.

Ensuring that Australian maternity services are equitable is outlined as one of the main purposes in the most recent maternity care reform guideline *'Woman-centred care: Strategic directions for Australian maternity services' (2019).* Yet, maternal healthcare reform has lacked accountability at both the state government and Hospital and Health Services level to implement the intended and agreed upon aims and direction of maternity care reform, which include ensuring that maternal health services are equitable (437). Greater commitment and accountability are required from Hospital and Health Services to ensure alongside targeted equity measurements to ensure that progress is made in improving the care for and meeting the needs of vulnerable women and babies.

The evidence of overuse of tertiary health care services, alongside evidence of reduced use of primary health services presented in this thesis, shows that there is likely a higher portion of maternity care resources such as funds, health workforce, and technologies, being channelled into hospital care compared to primary health services. This pattern is also mirrored in the funding of Australia's overall healthcare system (348). Although hospitals deliver the majority of maternity care, primary health institutions can play an important role in promoting health equity for rural and remote and First Nations women and babies. A better understanding of *how* to use maternal health care resources is required to ensure the health care needs of vulnerable populations are being met. State governments have the responsibility for equitable delivery of health services and these findings point to clear areas for improvement moving forward.

Macro-level health and financing policies are contributing to a pattern of inequitable maternal health care provision and coverage and an increasing medicalisation of childbirth

The results in this thesis are of particular importance for policymakers to ensure the equitable allocation of resources for vulnerable women and to consider the influence that contemporary health financing mechanisms are having on the increasing medicalisation of birth in Australia. The results showed that macro-level health and financing policies are contributing to a pattern of inequitable maternal health care provision and coverage and an increasing medicalisation of childbirth. The private health system in Australia was designed and introduced to allow for choice in health care provider and health service; to shift the costs onto those who can afford to pay more and to indirectly reduce hospital waiting times. However, all private health care promotes inequity since it is only accessible to those with the ability to pay. This means that only those who can afford the costs associated with private care receive the benefit of the expanded service choices. The consequence of introducing policies that promote the uptake of private health insurance is that

certain population groups are favored over others. For example, the pooling of public funds into the private health sector, which facilitates market-driven price-setting among private health care providers and insurance companies. At the same time, the results in this thesis demonstrate a lack of resources for needed public health care services including Midwifery Group Practice, which is potentially reflected in the higher unmet health needs of First Nations, rural and remote, and socioeconomically disadvantaged women and the over-demand for birth centres in public hospitals that offer this service.

The push towards private maternity care through healthcare financing mechanisms is not only contributing to a pattern of inequitable health service provision, but contributing to an increasing medicalisation of birth. The current financing mechanisms in both the public and private sector reward volume of care and do not take into account birth outcomes. Consideration needs to be given to implementing quality-based indicators that preference woman-centred outcomes during pregnancy and childbirth over funding models that reward volume of care.

The increasing use of obstetric interventions in Australia could also be attributable to the limited access to midwifery continuity of care models as a result of macro-level health and financing policies. Women who receive midwifery continuity of care models are less likely to have an instrumental birth and more likely to experience a normal vaginal birth (238, 239, 423). Access to maternity care services is mainly determined by Australia's health system structure and funding arrangements including Medicare, specialist and general practice, private health insurance, and other Australian, state, and territory government health funding models, including for public hospitals. A review of maternal health care in Australia (88) found that the funding mechanisms are not holistic as they are primarily medically focused and do not encompass other potentially important needs of women during the perinatal period.

The national maternity health reform agenda (460) came with the promises of increasing choice for women over their maternity care and autonomy over the birthing process; ensuring continuity of carer is a key element of care, and ensuring that care is woman-centered. At the beginning of the national maternity services reform process, a review and public and stakeholder consultation were conducted by the Department of Health and Ageing (88, 97). One of the major issues identified in the review process was the need to expand the range of models of maternity care. However, over the following decade, the maternal health reform process did not gain significant traction due to a lack of evaluation, which made it difficult to assess progress; a lack of true and meaningful collaboration between consumers, obstetricians, midwives, General Practitioners; a lack of representation from First Nations organisations and rural and remote clinicians; a lack of

transparency in the development of a new framework, and a lack of direction as to how accountability would be achieved and measured. The Australian Medical Association made an official complaint to both the Queensland and federal health ministers because of the lack of consultation from medical specialists when developing the framework (461, 462). The development of a new National Framework for Maternity Services was then temporarily halted (463-465). If maternal health care reform is going to increase the choice for women over their maternity care then greater visible action is required in the form of setting targets to meet alongside evaluation and transparent reporting of whether or not the targets are being met.

Strengths and limitations

One of the key strengths of this thesis is the use of a linked administrative dataset. The base population for the dataset was derived from the Perinatal Data Collection dataset, which collects information on all births in Queensland including the demographic and clinical details. The use of routinely collected administrative healthcare data from an entire population minimises the risk of selection bias as it does not limit the sample size of women from minority population groups that are often underrepresented in healthcare research (63). Another strength of the data used in this study is the completeness of First Nations status identification. Under-identification of Aboriginal and Torres Strait Islander people is common in many health-related data collections. Accurate identification of First Nations peoples is essential for measuring equity and effectiveness of health services in meeting the needs of First Nations people and for policy development, planning, and improvement of health service delivery. The Australian Institute of Health and Welfare evaluated national health datasets and found that the PDC dataset, whereby First Nations status was derived from in this thesis, has only 0.1% of 'not stated' status records (466).

While there are many strengths relating to its use, there are also inherent limitations of using administrative data such as the availability of relevant data variables. For example, the PDC does not collect information on individual or household incomes, therefore the measurement of socioeconomic status in this study is based on postcode and is area-based, and not measured at the individual level. Data on care providers are also not routinely collected. Due to differences in practice patterns between care providers, this may be an important determining factor of woman and childbirth outcomes and could provide further information on health provider factors and their association with the main outcomes presented in this thesis. Another limitation of this study is the reduced ability to determine the appropriateness of care and the actual prevalence of overuse as the individual preferences of women are not captured. Instead, we refer to the above optimal use of caesarean sections based on the World Health Organization stating that there is no demonstrated

benefit in a population when caesarean sections are above 10% (33). Finally, in this thesis, the outcomes of interest were process events and are not Patient-Reported Outcome Measures (PROMs). Therefore, the outcomes are not woman-centered, which means that such measures did not directly capture whether the outcomes of importance to the women giving birth were met.

Conclusion

This study presents a unique body of work on the patterns of maternal health service use among the Queensland population, and drivers of maternal healthcare trends from various levels of the health system. Based on the findings from this thesis, it can be concluded that variation in maternal health care provision and health service coverage exists between groups of women in Queensland, Australia. The thesis provides evidence that there is above optimal use of obstetric interventions, which is not solely attributable to the clinical need of women. The combined findings of overuse of costly obstetric interventions for urban, higher socioeconomic and non-First Nations women, and inadequate maternal health service coverage for rural and remote, First Nations and lower socioeconomic women provides evidence that healthcare resources for women in Queensland are inequitably distributed and that macro-level health and economic policies are in-part contributing to this trend.

These results are of particular importance for policymakers to ensure the equitable allocation of resources for vulnerable women and to consider the influence that contemporary health financing mechanisms are having on the increasing medicalisation of birth in Australia. Consideration needs to be given to implementing quality-based indicators that preference woman-centred outcomes during pregnancy and childbirth over funding models that reward volume of care, alongside prioritisation of access to publicly funded midwifery continuity of carer models. If maternal health care reform is going to achieve its intentions of Australian maternity services being 'equitable, safe, woman-centred, informed and evidence-based' (437), then more visible action is required including monitoring and evaluation of the intended reform objectives. In terms of future research, up-to-date data is required on the birth preferences of women to ensure that health services are designed in a way to meet the needs of all women and their families. A thorough investigation between the funding mechanisms and hospital- and health provider-level approaches to maternity care is required to determine the impact of these interactions on the delivery of maternity care. Governments, policymakers, and Hospitals and Health Services need to move beyond rhetoric and demonstrate tangible action and commitment to ensure that maternal health care is equitable, appropriate, accessible, safe, and woman-centred whereby autonomy is restored for all women who give birth in Australia.

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Appendices

Appendix 1

If mothers on the Maternity1000 dataset had an ICD-10-AM code that included either gestational hypertension; chronic hypertension; pre-eclampsia; eclampsia, and preeclampsia superimposed on chronic hypertension they were categorized as 'Hypertensive Disorders of Pregnancy'. If mothers had an ICD-10-AM code that included Gestational Diabetes they were categorized as 'gestational diabetes', or if they had an ICD-10-AM code or that including pre-existing (Type 1 or Type 2) Diabetes Mellitus then they were categorized as 'pre-existing diabetes'. If mothers on the dataset had an ICD-10-AM code that included either anxiety; depression; bipolar or schizophrenia they were categorized as having a 'mental health diagnosis'. Please refer to the ICD-10-AM codes used below.

ICD-10-AM codes

Hypertensive disorders of pregnancy: O149, O150, O13, O152, O159, O16, R03, O109, O104, I10, O11, I152, O100, O102, O103, O103, O104, O109.

Pre-existing diabetes: O244.2, O244.3.

Gestational diabetes: O244.4, O244.9.

Mental Health diagnosis: F3200, F3210, F3211, F3220, F3221, F3230, F3280, F3281, F3290, F3291, F330, F331, F332, F333, F339, F314, F313, F312, F339, F411, F412, F418, F419, F429, F430, F431, F432, F439, F440, F445, F449, F500, F502, F508, F530, F531, F6301.

MBS item numbers

Psychological support from a General Practitioner: 02700, 02701, 02712, 02713, 02715, 02717, 02721, 02725, 10956, 10968.

Referral to psychological therapy services: 00291

Psychological support from psychologist: 00293, 00296, 00297, 00359, 00361, 00348, 00350, 00352, 00319.

Chronic Disease Management: 00132, 00133, 00721, 00723, 00732.

Appendix 2.

Two datasets were used from the Maternity1000 linked administrative database, they include the Queensland Hospital Admitted Patient Data dataset and the Perinatal Data Collection dataset. The

Queensland Hospital Admitted Patient Data dataset was used to the Hospital and Health Service variables. On this dataset, the baby is recorded as either being born in a public health facility; private facility or home. Home births were excluded from the analysis. If the baby was recorded as being born in a public health facility, then the name of the hospital is also recorded. We used the names of the hospitals to create categories of Hospital and Health Service jurisdictions. If the birth was recorded as being in a private facility, then they remained in this category for the analysis.

The Perinatal Data Collection dataset was used to create all other variables used in the analysis, including obstetric interventions, socioeconomic, demographic and health status variables. On the Perinatal Data Collection dataset, the birth delivery mode is recorded as either classical caesarean section or lower segment caesarean section (we recoded these variables to be merged into one category 'caesarean section'); vaginal non-instrumental; forceps and vacuum extractor, which we categorised as outcome variables in the analyses. The Perinatal Data Collection dataset also records the method in which the labour commenced (spontaneous/no labour due to caesarean section/induced). If a mother was recorded has her labour onset as being 'induced' they were recoded into an 'induction of labour' variable. It is recorded on the Perinatal Data Collection dataset if a woman experiences any damage to her perineum (1st degree laceration/2nd degree laceration/3rd degree laceration/4th degree laceration/episiotomy). We recoded the variable so for any mothers that were recorded as having an episiotomy into an 'episiotomy' variable. The Perinatal Data Collection dataset also records whether a mother received any form of analgesia (general anesthetic/spinal/epidural/combined spinal and epidural) during labour and birth. This variable only refers to epidural for the purpose of analgesia and not to facilitate a caesarean section. We recoded the variable so that it included any mothers that had either 'epidural' or 'combined spinal and epidural' into an 'epidural' category.

During pregnancy, it is recorded on the Perinatal Data Collection dataset if women have any pre-existing medical conditions as either a yes/no response. A pre-existing health condition is defined in the Perinatal Data Collection as either pre-existing maternal conditions; hypertension or diabetes; and other diseases, illnesses or conditions arising during the current pregnancy including anaemia that is not directly attributable to pregnancy but may significantly affect care during the current pregnancy and/or pregnancy outcome. We recoded the data so that all women who were recorded as 'yes', were categorised into a 'pre-existing health condition' variable. Pregnancy complications for the current pregnancy are also recorded as yes/no response on the Perinatal Data Collection dataset. A pregnancy complication is defined as complications of pregnancy arising up to the period immediately preceding labour and delivery that are directly attributable to the pregnancy and may significantly affect care during the current pregnancy and/or the outcome. This can include:

Antepartum haemorrhage (Abruption, Placenta praevia, any other antepartum haemorrhage, or cause unknown) or gestational diabetes or hypertension. We recoded the data so that all women who recorded 'yes' were categorised into a 'pregnancy complication' variable.

Body Mass Index was calculated using the mothers' height and weight (weight (kg)/height (m2)), which are both recorded on the Perinatal Data Collection dataset. Maternal age was calculated based on the month and year of birth for the mother and the month and year she gave birth, which are both recorded on the Perinatal Data Collection dataset. If women reported 'yes' at their antenatal appointment as being either Aboriginal and or Torres Strait Islander then they were recoded and categorized as 'Indigenous'. If they reported no, then they were categorized as no (non-indigenous). 0.01% of Indigenous status were missing and they were excluded from the analysis. We categorised mothers' socioeconomic status based on mothers' postcode of residence at the time of birth, which is recorded in the Perinatal Data Collection dataset. Socioeconomic status was mapped to the the Australian Bureau of Statistics Index of Relative Socioeconomic Disadvantage. We ranked the study population into five ordinal categories (IRSD 1-5), with IRSD1 representing mothers living in areas of greatest socioeconomic disadvantage and IRSD5 representing mothers living in areas of the least socioeconomic disadvantage. Rurality, which was also based on the mothers' postcode at birth, was used to map to the the Accessibility/Remoteness Index of Australia (ARIA+) (56). We recoded the variable containing the mothers' postcode into levels of rurality. Index scores were consolidated into the following ordinal categories: Major Cities; Inner Regional; Outer Regional; Remote; and Very Remote. Information on smoking status is collected at two time points during antenatal care, which is before 20 weeks gestation and after 20 weeks gestation. This is then recorded on the Perinatal Data Collection dataset. We recoded the data so that variable 'smoking before 20 weeks gestation' was used as a 'smoking' status variable in our analyses.

After the data was cleaned and the variables were recoded, we merged the Queensland Hospital and Admitted Patient Data Collection dataset and the Perinatal Data Collection dataset into one dataset using the mother's unique identifier code and the birth episode. The PROC GENMOD procedure was used in SAS to undertake the multivariate regression analysis. We also included the LSMEANS statement in the models to produce adjusted mean percentages of obstetric interventions by Hospital and Health Service. A separate model was constructed for each of the outcome variables (caesarean section, Non-instrumental vaginal birth, forceps and vacuum, induction of labour, episiotomy and epidural). The confounding variables that were included into each analysis were rurality (remote and very remote); socioeconomic disadvantage (IRSD1); medical condition (yes); Smoking status before 20 weeks gestation (yes); Indigenous status (yes); BMI (>25); and age (>34). Due to their known statistical impact on outcomes in childbirth, this broad spectrum of maternal

characteristics have been reported in the literature as important case-mix variables to adjust for when comparing variation in maternal health outcomes between hospitals. In our analyses, we found that almost all of these variables had a significant effect on all of the outcomes of interest, and therefore they were kept in the final models.

The below table reports the adjusted mean percentages of obstetric interventions by Hospital and Health Service and the effects of coefficient variables and their level of significance.

Table 5.4. Adjusted mean percentages of obstetric interventions by Hospital and Health service and coefficients.

Hospital and Health Service	***Caesarean section***	***Instrumental vaginal birth***	***Non-instrumental vaginal birth***	***Induction of labour***	***Episiotomy***	***Epidural analgesia***
Private sector						
Private hospitals	45.8	12.8	41.4	27.8	7.68	19.23
Public Sector						
Metropolitan						
Townsville	31.6	9.4	59	23.9	7.56	12.38
Mater Hospitals	29.9	13.1	57	29	8.63	15.67
Metro South	30.9	7.9	61.2	25.2	4.90	15.23
Sunshine Coast	27.9	10.7	61.4	22.9	3.88	18.74
Metro North	27.8	10.7	61.5	18.1	7.14	16.30
Gold Coast	23.6	10.7	65.7	26.7	5.32	15.97
Variation in % points	8	5.2	8.7	11	4.8	6.36
Regional						
Cairns and Hinterland	30.7	10.6	58.7	21.2	5.37	15.34
Central QLD	29.9	7.3	62.8	20	6.12	11.38
Wide Bay	29.8	10.4	59.8	24.3	6.44	15.00
Darling downs	28.9	8.1	63	19.9	5.40	14.95
Mackay	28	12.8	59.8	24.9	6.77	15.18
West Moreton	26.5	7.8	65.7	23.1	5.28	13.40

Variation in % points	4.2	5.5	7	5	1.5	4
Rural and remote						
South West	36.2	10.3	53.9	16.97	5.47	8.98
North West	29.2	12.7	58.2	26.11	10.04	17.46
Central West	28.2	11.6	60.7	25.65	4.86	11.85
Torres and Cape	22.3	6.2	71.6	15.58	4.22	7.95
Variation in % points	13.9	6.5	17.7	10.6	5.8	9.5
Coefficients						
Rurality	-0.0016***	-0.0084***	0.0102***	0.0095***	-0.0054***	-0.0137***
IRSD	-0.0076***	-0.0056***	0.0019*	-0.0049***	-0.0045***	0.0108***
Indigenous	0.0034	-0.0306***	0.0271***	-0.0256***	-0.0187***	-0.0374***
Medical condition	0.0181***	0.0007	-0.0179***	0.0165***	0.0059***	0.0072**
Pregnancy complication	0.3414***	-0.0132***	-0.3283***	0.2159***	-0.0012***	0.0499***
Smoking	-0.0115**	0.0022***	-.0448***	-0.0061***	-0.0216***	-0.0247***
BMI	0.005***	-0.0002***	-0.0002***	0.0002**	0.0002***	0.00
Age	0.0089***	-0.0037***	-.0054***	-0.0033***	-0.0026***	-0.0052***

Note: **p sig at .05 **p sig at .01. ***p sig at .001.*

Appendix 3

Table 6.5. Independent variables included in the classification tree model

Pre labour and birth characteristics	**Labour and delivery complications**	**Birth interventions**
Intrauterine Growth Restriction	Maternal exhaustion	Artificial rupture of membranes
Hypertensive Disorders During Pregnancy	Cephalopelvic disproportion	Oxytocin augmentation or induction of labour
Diabetes during pregnancy	Obstructed labour	Epidural analgesia
Anaemia	Uterine inertia	Vacuum
Multiple gestation	Compression of umbilical cord	Forceps
Maternal age over 35	Oligohydramnios	

Assisted conception	Fetal malpresentation (breech, brow, cephalic, face, oblique, transverse, shoulder)
Socioeconomic status	Fetal stress
Body Mass Index >25	Preterm birth (<38 weeks gestation)
Fetal congenital anomaly	Compression of umbilical cord
Aboriginal and/or Torres Strait Islander status	Birth weight >4kgs
Rural or remote dwelling	Low birthweight 2,500 grams
	Shoulder dystocia
	Stillbirth

Appendix 4

Variable Importance Definitions

Count: The count-based variable importance counts the number of times in the tree that a particular variable is used in a split.

Surrogate count: A surrogate count totals the number of times that a variable is used in a surrogate splitting rule. The surrogate splitting rule handles the assignment of observations by using an alternative variable that has similar predictive ability and has non-missing values in observations where the primary predictor is missing.

Residual sum of squares (RSS): The RSS-based metric measures variable importance is based on the change of RSS when a split is found at a node. The change is

- $\Delta_d = RSS_d - \sum_i RSS^d_i$

where

- d denotes the node
- i denotes the index of a child that this node has
- RSSd is the RSS if the node is treated as a leaf
- RSSd i is the RSS of the node after it has been split

Relative importance: The relative importance metric is a number between 0 and 1. It is calculated in two steps. First, the HPSPLIT procedure finds the maximum RSS-based variable importance. Then, for

each variable, it calculates the relative variable importance as the RSS-based importance of this variable divided by the maximum RSS-based importance among all the variables.

To further validate the association between intrapartum interventions and the top two reasons for caesarean section – 'primary inadequate contractions' and 'fetal heart rate anomaly' – we conducted chi-square analysis.

The results in Table 6.6 show that mothers that were reported as having ''primary inadequate contractions' had a significantly higher percentage of artificial rupture of membranes, induction of labour, epidural analgesia and primary caesarean section compared to mothers who did not have primary inadequate contractions. There was a higher percentage of mothers in the 'no primary inadequate contractions' group that had an instrumental birth (vacuum and forceps).Mothers that were reported to have fetal heart rate anomaly had a significantly higher percentage of artificial rupture of membranes, induction of labour, epidural analgesia, vacuum delivery, forceps delivery and primary caesarean section compared to mothers who did not have fetal heart rate anomaly.

Appendix 5

0.62.0 Primary inadequate contractions

- Failure of cervical dilation
- Primary hypotonic uterine dysfunction
- Uterine inertia during latent phase of labour

0.68.0 Labour and delivery complicated by fetal heart rate anomaly

Fetal:

- Bradycardia
- Heart rate irregularity
- Tachycardia
- *Excludes:* with meconium in amniotic fluid

Appendix 6

Table 6.6. Frequency and percentage (%) of intrapartum interventions for mothers who had no history of previous caesarean section and experienced primary inadequate contractions and fetal rate anomaly, compared to mothers who did not.

	Primary inadequate contractions	No Primary inadequate contractions	P value	Fetal heart rate anomaly	No Fetal heart rate anomaly	P value
Artificial rupture of membranes	706 (38.5)	20,102 (26.9)	<.0001	1,034 (33.9)	19,774 (26.9)	<.0001
Induction of labour	700 (38.1)	8,407 (11.3)	<.0001	684 (22.4)	8,423 (11.5)	<.0001
Epidural analgesia	1,476 (80.4)	15,277 (20.44)	<.0001	1,639 (53.7)	15,114 (20.6)	<.0001
Vacuum	0 (0)	3,571 (4.8)	<.0001	799 (26.2)	2,772 (3.8)	<.0001
Forceps	0 (0)	1,110 (1.5)	<.0001	224 (7.3)	886 (1.2)	<.0001
Primary caesarean section	1,836 (100)	9,263 (12.4)	<.0001	1,283 (42.1)	9,816 (13.4)	<.0001

To further validate the association between intrapartum interventions and the top two reasons for caesarean section – 'primary inadequate contractions' and 'fetal heart rate anomaly' – we conducted chi-square analysis.

The results in Table 6.6 show that mothers that were reported as having ''primary inadequate contractions' had a significantly higher percentage of artificial rupture of membranes, induction of labour, epidural analgesia and primary caesarean section compared to mothers who did not have primary inadequate contractions. There was a higher percentage of mothers in the 'no primary inadequate contractions' group that had an instrumental birth (vacuum and forceps).Mothers that were reported to have fetal heart rate anomaly had a significantly higher percentage of artificial rupture of membranes, induction of labour, epidural analgesia, vacuum delivery, forceps delivery and primary caesarean section compared to mothers who did not have fetal heart rate anomaly.

Appendix 7

Table 7.4. Independent variables included in the classification tree model

Pre labour and birth characterisitcs	**Labour and delivery complications**	**Birth interventions**
Intrauterine Growth Restriction	Maternal exhaustion	Artificial rupture of membranes
Hypertensive Disorders During Pregnancy	Cephalopelvic disproportion	Oxytocin augmentation or induction of labour
Diabetes during pregnancy	Obstructed labour	Epidural analgesia
Anaemia	Uterine inertia	Vacuum
Multiple gestation	Compression of umbilical cord	Forceps
Maternal age over 35	Oligohydramnios	
Assisted conception	Fetal malpresentation (breech, brow, cephalic, face, oblique, transverse, shoulder)	
Socioeconomic status	Fetal stress	
Body Mass Index >25	Preterm birth (<38 weeks gestation)	
Fetal congenital anomaly	Compression of umbilical cord	
Aboriginal and Torres Strait Islander Status	Birth weight >4kgs	
Rural or remote dwelling	Low birthweight <2.5kgs	
	Shoulder dystocia	

Appendix 8:

Table 8.3 Documents included in the review

Author/organisation	Date of manuscript	Type of manuscript	Document title	Funding	Pooling	Purchase
Administrator National Health Funding Pool	23-Feb-16	Website: www.publichospitalfunding.gov.au	The role of the Administrator		✓	
Administrator National Health Funding Pool	1-Jun-17	Annual report	2016-17 Administrator National Health Funding Pool Annual Report			
Amanda Biggs, Parliament of Australia	29-Oct-04	Policy background brief	Medicare - Background Brief			✓
Australian Bureau of Statistics	27-Mar-17	Website: www.abs.gov.au	Private Health Insurance	✓		
Australian Bureau of Statistics	29-Oct-02	Website: www.abs.gov.au	Private Medical Practitioners, Australia, 2002			✓
Australian Government, Private Health Insurance Ombudsman	Mar-17	Website: www.privatehealth.gov.au	Australian Government Private Health Insurance Rebate		✓	
Australian Government, Private Health Insurance Ombudsman	9-Jul-05	Website: www.privatehealth.gov.au	Out of pocket expenses (gap cover)	✓		

Australian Government	2015	Australian Government website	How Government works	✓		
Australian Government	26-Mar-14	Australian Government Senate inquiry	Out-of-pocket costs in Australian healthcare	✓	✓	✓
Australian Government, Australian Prudential Regulation Authority	6-Nov-17	Australian Government Department Annual Financial Activities Report	The Operations of Private Health Insurers Annual Report 2016/17	✓		
Australian Government, Australian Prudential Regulation Authority	16-Aug-17	Australian Government Department Report	Private Health Insurance Medical Gap	✓		
Australian Government, Australian Taxation Office	29-Jun-17	Website: www.ato.gov.au	Medicare levy reduction for low-income earners	✓		
Australian Government, Australian Taxation Office	29-Jun-17	Website: www.ato.gov.au	Medicare levy surcharge	✓		
Australian Government, Australian Taxation Office	29-Jun-17	Website: www.ato.gov.au	Medicare levy	✓		
Australian Government, Department of Health	Nov-17	Website: www.health.gov.au	Lifetime Health Cover		✓	

Australian Government, Department of Health	26-Oct-17	Website: www.health.gov.au	Changes to MBS items for Obstetric Services Frequently Asked Questions	✓
Australian Government, Department of Health	1-Jul-17	Medicare Schedule	Medicare Benefits Schedule Book	✓
Australian Government, Department of Health	2011	Website: www.health.gov.au	Provision of maternity care	✓
Australian Government, Department of Health	1-Dec-15	Website: www.pbs.gov.au	Pharmaceutical Benefits Scheme (PBS)	✓
Australian Government, Department of Health	1-Dec-15	Website: www.pbs.gov.au	Patient Charges	✓
Australian Government, Department of Health	11-Oct-17	Website: www.pbs.gov.au	PBS Frequently asked questions	✓
Australian Government, Department of Health	11-Nov-16	Website: www.health.gov.au	Child and Maternal Health	✓
Australian Government, Department of Health	2013	www.health.gov.au	Eligible Midwives Questions and Answers	✓

Australian Government, Department of Health	2009	Senate inquiry	Submission to the Senate Standing Committee on Community Affairs for the Inquiry into the Health Insurance Amendment (Extended Medicare Safety Net) Bill 2009	✓	✓
Australian Government Department of Human Services	2017	Website: www.humanservices.gov.au	Medicare Bulk Billing		✓
Australian Institute of Health and Welfare	13-Sep-16	Australian Government Department National Annual Health Report	Australia's Health, 2016		✓
Australian Institute of Health and Welfare	7-May-08	Australian Government Department National Annual Health Report	Australia's Health, 2008		✓
Australian Institute of Health and Welfare	2000	National Maternal and Child Health Report	Australia’s mothers and babies		✓
Australian Institute of Health and Welfare	2008	National Maternal and Child Health Report	Australia’s mothers and babies		✓
Australian Institute of Health and Welfare	2017	National Maternal and Child Health Report	Australia’s mothers and babies 2016 – in brief		✓

Australian Institute of Health and Welfare	2017	National Annual Health Expenditure Report	Health expenditure Australia 2015-16			✓
Australian Institute of Health and Welfare	1-Jun-15	Australian Government Department National Aboriginal and Torres Strait Islander Health Report	The health and welfare of Australia's Aboriginal and Torres Strait Islander peoples		✓	✓
Australian Institute of Health and Welfare	July 2016	Annual national hospital resources report	Hospital resources 2014-15: Australian hospital statistics		✓	✓
Australian Institute of Health and Welfare	17-Sept-14	Literature review	Nomenclature for models of maternity care: literature reivew			✓
Australian Local Government Association	2-Jul-05	National Local Government report	Health and wellbeing			✓
Barry Burgan, the University of Adelaide	2015	Academic report	Funding a viable and effective health sector in Australia	✓		
Bupa	2017	Private Health Insurance website	Bupa seeks to deliver gap free childbirth	✓		
Consumers Health Forum of Australia	7-Jan-16	Position Statement	Preserving Consumer Choices Without Sacrificing the	✓		

			Principles of Universal Health Care		
Council of Australian Governments	1-Jul-17	Legislative document	National Health Reform Agreement	✓	
Natasha Donnolley, Georgina Chambers, Kerryn Butler-Henderson, Michael Chapman and Elizabeth Sulivan	2017	Peer review publication in an academic journal	The Maternity Care Classification System – A validated system for classifying models of care		✓
Natasha Donnolley, Kerryn Butler-Henderson, Michael Chapman and Elizabeth Sullivan	2016	Peer review publication in an academic journal	The development of a classification system for maternity models of care		✓
Natasha Donnolley, Georgina Chambers, Kerryn Butler-Henderson, Michael Chapman and Elizabeth Sullivan	2017	Peer review publication in an academic journal	More than a name: Heterogeneity in characteristics of models of maternity care reported from the Australian Maternity Care Classification System validation study		✓
Natasha Donnolley, Georgina Chambers, Kerryn Butler-	2017	Peer review publication in an academic journal	A Validation study of the Australian Maternity Care Classification System		✓

Henderson, Michael Chapman and Elizabeth Sullivan					
Einarsdóttir, Kemp, A.b, Haggar, F.A.b, Moorin, R.E.b,c, Gunnell, A.S.d, Preen, D.B.b, Stanley, F.J.a, Holman, C.D.J.b	23-Jul-12	Peer review publication in an academic journal	Increase in caesarean deliveries after the Australian private health insurance incentive policy reforms		✓
Emily Callander & Haylee Fox	Dec-17	Peer review publication in an academic journal	Changes in out-of-pocket charges associated with obstetric care provided under Medicare in Australia		✓
Independent Hospital Pricing Authority	8-Aug-17	Independent Government Agency Publication	Activity Based Funding	✓	
J Hall	6-Aug-15	Peer review publication in an academic journal	Australian health care - The challenge of reform in a fragmented system		✓
Julie Smith	1-Dec-01	Peer review publication in an academic journal	Tax expenditures and Public Health Financing in Australia		✓
Madeline Taylor	Jul-12	Peer review publication in an academic journal	Is it a levy, or is it a tax, or both?	✓	

McLachlan HL, Forster DA, Davey MA, Farrell T, Gold L, Biro MA et al.	Nov-12	Peer review publication in an academic journal	Effects of continuity of care by a primary midwife (caseload midwifery) on caesarean section rates in women of low obstetric risk: the COSMOS randomised controlled trial			✓
National Rural Health Alliance Ltd.	31-Jul-17	A Working Document to inform policy	The little book of rural health numbers		✓	
Parliament of Australia	29-Mar-17	Parliamentary Communique	Value and affordability of private health insurance and out-of-pocket medical costs	✓		✓
Australian Healthcare & Hospitals Association	29-Mar-17	Website: www.aph.gov.au	Value and affordability of private health insurance and out-of-pocket medical costs	✓		
Richard Denniss	1-Nov-05	Peer review publication in an academic journal	Who Benefits from Private Health Insurance in Australia?		✓	
Rosemary Bryant, Commonwealth of Australia	Feb-09	Australian Government Report	Improving Maternity Services in Australia			✓

Sandall J, Soltani H, Gates S, Shennan A, Devane D	Feb-17	Peer review publication in an academic journal	Midwife-led continuity models versus other models of care for childbearing women		✓
Stephen Robson, Paula Laws and Elizabeth Sullivan	4-May-09	Peer review publication in an academic journal	Adverse outcomes of labour in public and private hospitals in Australia: a population-based descriptive study		✓
Shorten B, Shorten A	2004	Peer review publication in an academic journal	Impact of private health insurance incentives on obstetric outcomes in NSW hospitals	✓	
SK Tracy, Welsh A, Hall B, Hartz D, Lainchbury A, Bisits A, et al.	2014	Peer review publication in an academic journal	Caseload midwifery compared to standard or private obstetric care for first time mothers in a public teaching hospital in Australia: a cross sectional study of cost and birth outcomes	✓	
SK Tracy, MB Tracy	Aug-03	Peer review publication in an academic journal	Costing the cascade: estimating the cost of increased obstetric	✓	

			intervention in childbirth using population data		
Stephen Duckett, Grattan Institute	Mar-13	Think Tank Policy Report	Australia's bad drug deal		✓
David Richardson, the Australian Institute	May-17	Think tank discussion paper	Time for a progressive Medicare levy	✓	
The Royal Women's Hospital	9-Jul-05	Public Hospital Website	Pregnancy care & birthing options		✓
Kees Van Gool Elizabeth Savage Rosalie Viney Marion Haas Rob Anderson	31-May-09	Peer review publication in an academic journal	Who's getting caught? An analysis of the Australian Medicare Safety Net		
Australian Institute of Health and Welfare	13-Jun-19	National annual report	Disease expenditure in Australia		✓
Amanda Biggs	2018	Update on policy developments	Recent developments in federal government funding for public hospitals: a quick guide	✓	

Australian Prudential Regulation Authority	21-May-19	Private health insurance statistics	Quarterly Private Health Insurance Statistics. March 2019	✓		✓
Stephen Duckett & Kristina Nemet	Jul-19	Think Tank Working Paper	The history and purposes of private health insurance.	✓	✓	✓